U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-272 097

Greensboro-Guilford County, North Carolina, 201 Wastewater Treatment System, EPA Project Nos. C37037601, C37036901

Environmental Protection Agency, Atlanta, Ga. Region IV

Jul 77

PB 272 097

EPA 904/9-77-018

DRAFT
ENVIRONMENTAL IMPACT STATEMENT

GREENSBORO – GUILFORD COUNTY, NORTH CAROLINA
201 WASTEWATER TREATMENT SYSTEM

PROJECT NUMBERS C37037601
C37036901

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IV
ATLANTA, GEORGIA 30308

IN COOPERATION WITH
THE STATE OF NORTH CAROLINA
DEPARTMENT OF NATURAL AND ECONOMIC RESOURCES
RALEIGH, N.C. 27611

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

BIBLIOGRAPHIC DATA SHEET	1. Report No. EPA 904/9-77-018	2.	3. Recipient's Accession No. PB-272 097
4. Title and Subtitle Draft EIS Greensboro-Guilford County, N.C. 201 Wastewater treatment System Project No. C37037601 & C37036901			5. Report Date July, 1977 6.
7. Author(s) EIS Preparation Section, EPA Region IV Atlanta, GA			8. Performing Organization Rept. No.
9. Performing Organization Name and Address Environmental Protection Agency, Region IV EIS Branch 345 Courtland St. Atlanta, GA 30308			10. Project/Task/Work Unit No. 11. Contract/Grant No.
12. Sponsoring Organization Name and Address			13. Type of Report & Period Covered Draft EIS 14. 904/xx

15. Supplementary Notes

16. Abstracts

The subject action of this Draft Environmental Impact Statement is the awarding of grant funds to the City of Greensboro, N.C. for the purpose of developing a wastewater treatment system to service The Greensboro-Guilford County area. Major issues involved in this EIS are plant site location primary and secondary land use and related social impacts. The EIS consists of three major sections.

These are a description of the existing environment, an evaluation of alternatives, and a more detailed evaluation of the effects of the chosen alternative. A detailed evaluation was made of seven system alternatives. The proposed action consists of upgrading the existing North Buffalo Creek Treatment Plant to tertiary treatment at 16 million gallons per day, abandoning the existing S. Buffalo Creek Treatment Plant, constructing a 60-inch diameter outfall from that plant location to a new 20 million gallon per day plant located 26,000 feet downstream on S. Buffalo Cree.

17. Key Words and Document Analysis. 17a. Descriptors

Greensboro, N.C.
wastewater
treatment system
South Buffalo Creek
Guilford County

17b. Identifiers/Open-Ended Terms

17c. COSATI Field Group

18. Availability Statement unlimited release	19. Security Class (This Report) UNCLASSIFIED	21. No. of Pages 330
	20. Security Class (This Page) UNCLASSIFIED	22. Price PCA15-A01

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IV
345 COURTLAND STREET
ATLANTA, GEORGIA 30308

August 23, 1977

NOTICE

The Environmental Protection Agency, Region IV, has recently furnished you with a copy of the Draft Environmental Impact Statement on the Greensboro-Guilford County, North Carolina 201 Wastewater Treatment System, Project Numbers C37037601 and C37036901. This copy contains two errors which should be corrected. The construction cost figure presented in the Description of the Proposed Action section on page 9 should be $33,345,000. Also, the maps of alternative 6 presented on page 8 and page III-20 should show a force main running from the existing South Buffalo Creek Plant to the existing North Buffalo Creek Plant.

DRAFT ENVIRONMENTAL IMPACT STATEMENT

GREENSBORO-GUILFORD COUNTY, NORTH CAROLINA
201 WASTEWATER TREATMENT SYSTEM

EPA PROJECT NOS. C37037601
C37036901

Prepared by
Environmental Protection Agency
Region IV
345 Courtland Street, N. E.
Atlanta, Georgia 30308

Approved

John A. Little July 13, 1977
Acting Regional Administrator Date

In cooperation with
the State of North Carolina
Department of Natural and Economic Resources
Raleigh, North Carolina 27611

Approved

July 18, 1977
Secretary Date

SUMMARY SHEET FOR ENVIRONMENTAL IMPACT STATEMENT

Greensboro-Guilford County, North Carolina
201 Wastewater Treatment Facilities
Project No. C-37037601
C-37036901

Draft (X)
Final ( )

Environmental Protection Agency
Region IV
345 Courtland Street
Atlanta, Georgia 30308

1. Type of Action: Administrative Action (X)
Legislative Action ( )

2. Brief Description of Proposed Action:

This Environmental Impact Statement was prepared in response to the action of awarding grant funds to the City of Greensboro, North Carolina for the purpose of developing a wastewater treatment system to service the Greensboro-Guilford County area. The project consists of the necessary facilities to process and treat approximately 36 million gallons per day (MGD) of wastewater. Guilford County, North Carolina will be potentially affected by the proposed action.

Physically, the proposed action consists of upgrading the existing North Buffalo Creek Treatment Plant (NBP) to tertiary treatment at 16 MGD, abandoning the South Buffalo Creek Treatment Plant (SBP), constructing a 60-inch diameter outfall from that plant location to a new 20 MGD plant located 26,000 feet downstream on South Buffalo Creek.

The proposed action will provide for:

(1) the removal of inadequately treated wastewater discharged from the municipal wastewater treatment system

(2) wastewater treatment facilities to accommodate existing and future sources of wastewater

(3) allowance for orderly growth in Greensboro-Guilford County area

3. Summary of Major Environmental Impacts

Direct adverse impacts associated with the proposed action are minor. Sewer construction and construction activity at the new plant site will cause short-term, minor stream siltation and increased air-borne particulates. Some natural vegetation will also be destroyed, continuing a trend to habitat fragmentation. Some human inhabitants will be subjected to temporary noise levels that exceed acceptable thresholds. Water quality will be improved in the lower stream reaches, but stream quality will remain stressed in the immediate Greensboro vicinity due to industrial discharges and urban runoff. A 26,000-foot segment of South Buffalo Creek below the existing facility will undergo a substantial decrease in flow. Abandonment of the existing South Buffalo plant may cause a requirement for vector[1] control downstream of the existing municipal outfall for several years. The proposed action is well-matched to projected growth patterns, accommodating desired growth while discouraging urban sprawl and other unplanned growth.

Important adverse secondary impacts include increased flooding and the necessity for potentially unsound flood control measures, an increase in urban runoff of poor quality that degrades streams and reduces aquatic habitat quality, continued terrestrial habitat attrition through residential and industrial growth, and increased air pollution through population growth.

Major beneficial impacts beyond any water quality improvements include elimination of the notorious odor source of the old South Buffalo Plant which adversely affected several hundred people and the possibility for planning orderly urban growth without environmentally unsound sprawl or other effects.

4. Summary of Alternatives Considered

The EIS process identified design flows that were at significant variance with those used for alternatives development in the 201 Facilities Plan. Using the EIS design flows, 124 possible alternatives were identified as candidates. From low and medium level screening analyses, these were reduced to 46, then to 11, and finally to seven which are presented in this Draft EIS.

Alternative 1 - Upgrade NBP to 16 MGD; upgrade and expand SBP to 20 MGD; construct an outfall sewer from SBP to Highway 70.

Alternative 2 - Upgrade NBP to 16 MGD; abandon SBP; construct new 20 MGD plant 14,000 feet downstream from SBP; construct interceptor to Highway 70.

---

[1] Disease carrying or transmitting insects, e.g., flies, mosquitos.

Alternative 3 - Upgrade NBP to 16 MGD; abandon SBP; construct new 20 MGD plant 26,000 feet downstream; construct outfall from SBP to new plant.

Alternative 4 - Upgrade NBP to 16 MGD; abandon SBP; construct new plant 46,500 feet downstream on Buffalo Creek; construct outfall from SBP to new plant.

Alternative 5 - Upgrade NBP to 16 MGD; abandon SBP; construct new plant 66,500 feet downstream on Buffalo Creek; construct outfall from SBP to new plant; construct outfall from new plant to Reedy Fork Creek.

Alternative 6 - Upgrade NBP to 16 MGD; expand NBP to 25 MGD in 1987; upgrade SBP to 11 MGD; construct force main from SBP to NBP.

Alternative 7 - Upgrade NBP at existing capacity; upgrade SBP to existing capacity.

5. Comments on the Draft Statement have been requested from the following:

Federal Agencies

Bureau of Outdoor Recreation
U.S. Coast Guard
Corps of Engineers
Council on Environmental Quality
Department of Commerce
Department of Health, Education, and Welfare
Department of the Interior
Department of Transportation
Department of Housing and Urban Development
Economic Development Administration
Federal Highway Administration
Fisheries and Wildlife Service
Food and Drug Administration
Forest Service
Geological Survey
National Park Service
Soil Conservation Service
Federal Energy Administration
Federal Power Commission

Members of Congress

Honorable Robert Morgan	U.S. Senate
Honorable Jesse A. Helms	U.S. Senate
Honorable Richardson Pryor	U.S. House of Representatives

State

James B. Hunt, Governor
Office of Intergovernmental Relations
North Carolina Department of Natural and Economic Resources
Council of Governments
Division of Archives and History

Commission of Agriculture
Office of State Planning
North Carolina Wildlife Resources Commission

Local

Mayor, City of Greensboro, North Carolina
Chairman, Guilford County Commission
Chairman, Piedmont Triad Council of Governments

Interested Groups

Greensboro Chamber of Commerce
Board of Realtors
Greensboro Citizens Association
North Carolina A & T University
Environmental Action Coalition
League of Women Voters
Rural/Suburban Community
The Sierra Club
Guilford County Advisory Board for Environmental Quality
Concerned Citizens of McLeansville
McLeansville Community Council
Piedmont Council of Engineering and Technical Societies
NAACP
GATEWAYS
McLeansville Merchants Association
Greensboro Jaycees
Audubon Society
Homebuilders Association

6. Date made available to CEQ and the Public

The Draft Statement was made available to the Council on Environmental Quality and the Public on July 29, 1977.

TABLE OF CONTENTS

Page

SUMMARY SHEET FOR ENVIRONMENTAL IMPACT STATEMENT............ i
SUMMARY.. 1
I. INTRODUCTION.. I-1
- A. Legislative and Legal Aspects............................. I-1
- B. Local Perspectives.. I-2
- C. Project History... I-4

II. DESCRIPTION OF EXISTING ENVIRONMENT........................ II-1
- A. Natural Environment....................................... II-2
  - 1. Physical Components................................... II-2
    - a. Climate... II-2
    - b. Odor.. II-6
    - c. Air Quality....................................... II-8
    - d. Noise... II-12
    - e. Geology... II-16
    - f. Soils... II-20
    - g. Hydrology... II-26
    - h. Sensitive Areas................................... II-51
  - 2. Biological Components................................. II-54
    - a. Terrestrial Environment........................... II-54
    - b. Aquatic Environment............................... II-63
- B. Man-Made Environment...................................... II-81
  - 1. Demography and Economics.............................. II-81
    - a. Current Population Data........................... II-81
    - b. Current Economic Conditions....................... II-91
    - c. Population Projections............................ II-94
  - 2. Land Use.. II-102
    - a. Present General Land Use.......................... II-102
    - b. Future General Land Use........................... II-109
  - 3. Community Services and Facilities..................... II-115
    - a. Police.. II-115
    - b. Fire Protection................................... II-116
    - c. Solid Waste Disposal.............................. II-116

Page
d. Schools.............................. II-119
e. Libraries............................ II-120
f. Health............................... II-120
g. Welfare.............................. II-121
h. Administrative Facilities............ II-121
4. Taxes and Budgeting.................. II-121
5. Archaeological, Cultural, Historical, and Recreational Resources............... II-123
a. Archaeology.......................... II-123
b. Historical Resources................. II-124
c. Recreational Facilities.............. II-127
6. Transportation....................... II-127
7. Resource Use......................... II-129
a. Existing Electricity Use............. II-129
b. Projected Electrical Use............. II-132
c. Natural Resource Users............... II-132
8. Water and Wastewater Services........ II-133
a. Water Supply and Distribution........ II-133
b. Wastewater Collection and Treatment........................... II-135
III. SYSTEM ALTERNATIVES.................. III-1
A. Introduction......................... III-1
B. Design Flow.......................... III-2
C. Development of System and Subsystem Alternatives......................... III-5
1. Approach............................. III-5
2. Capability of Existing Facilities.... III-5
3. Wastewater Treatment Process Alternatives......................... III-6
a. Physical/Chemical Processes.......... III-7
b. Biological Processes................. III-7
4. Effluent Disposal Alternatives....... III-8
a. Direct Discharge to Receiving Streams.............................. III-8

Page

b. Land Application.......................... III-9
c. Recycle/Reuse.............................. III-9
d. Subsurface Injection....................... III-10
5. Sludge Disposal Alternatives............... III-10
6. Non-Structural Alternatives................ III-11
7. Location Alternatives...................... III-13
D. Description of Alternatives Selected for Evaluation.................................... III-16
E. Effluent Limitations and Selection of Unit Processes.............................. III-21
F. Evaluation of Alternatives................. III-25
1. General Methodology........................ III-25
a. Environmental Rankings..................... III-25
b. Cost Rankings.............................. III-27
2. Results.................................... III-28
a. Environmental Rankings..................... III-28
b. Cost Rankings.............................. III-34
3. Other Evaluation Criteria.................. III-36
a. Implementability........................... III-36
b. Reliability................................ III-37
c. Resource Utilization....................... III-38
G. Conclusions................................ III-38
IV. DESCRIPTION OF PROPOSED ACTION.................. IV-1
A. Description of Proposed Facilities......... IV-1
1. Existing North Buffalo Facility............ IV-1
2. New South Buffalo Facility................. IV-10
3. Collection and Sewer System................ IV-17
V. ENVIRONMENTAL EFFECTS OF THE PROPOSED ACTION...... V-1
A. General.................................... V-1
B. Natural Environment........................ V-2
1. Physical Components........................ V-2
a. Air Quality................................ V-2
b. Odor....................................... V-4

Page
c. Noise.............................. V-7
d. Geology............................ V-16
e. Soils.............................. V-18
f. Water.............................. V-20
g. Land/Water Interface................ V-41
2. Biological Components.............. V-43
a. General............................ V-43
b. Land............................... V-44
c. Water.............................. V-46
d. Sensitive Biological Areas......... V-49
C. Man-Made Environment................ V-50
1. Demography and Economics............ V-50
2. Land Use............................ V-54
3. Community Services and Facilities... V-57
4. Taxes and Budgeting................. V-59
5. Archaeological, Cultural, Historical, and Recreational Resources.......... V-60
6. Transportation...................... V-62
7. Resource Use........................ V-63
VI. UNAVOIDABLE ADVERSE IMPACTS AND MITIGATING MEASURES.......................... VI-1
A. Natural Environment................. VI-1
1. Air Quality......................... VI-1
2. Odor................................ VI-1
3. Noise............................... VI-3
4. Geology............................. VI-4
5. Soils............................... VI-4
6. Water............................... VI-4
7. Land/Water Interface................ VI-10
8. Biology............................. VI-11
B. Man-Made Environment................ VI-13
VII. COORDINATION WITH OTHERS........... VII-1
BIBLIOGRAPHY........................... B-1

SUMMARY

This Environmental Impact Statement was prepared jointly by the State of North Carolina Department of Natural and Economic Resources and the Environmental Protection Agency, Region IV, in response to legal requirements of the State of North Carolina and the United States. It addresses those areas stipulated by the National Environmental Policy Act of 1969, the North Carolina Environmental Policy Act of 1971, and the Council on Environmental Quality Guidelines of August, 1973.

1. Existing Environment

For the purposes of this Environmental Impact Statement (EIS) the study area includes most of Guilford County as shown in Figure 1. The total environment is divided into natural and man-made aspects and each, while interactive, are discussed separately. Figure 1 also shows the designated 201 area and existing wastewater treatment facilities of Greensboro, North Carolina. Supporting documentation is provided in a Technical Reference Document (RA-R-406).

a. Natural Environment

Greensboro has a humid, subtropical climate characterized by relatively short, mild winters and long, hot summers. Precipitation is abundant. North-northeasterly and south-southeasterly winds prevail during the year as a result of high pressure systems which progress across the eastern United States.

Presently, the general air quality of the study area is good with respect to the criteria pollutants. Guilford County is designated an Air Quality Maintenance Area for suspended particulates. This designation has implications regarding the future growth of suspended particulate levels. Air pollutant emissions in the study area are typical of a moderately industrialized urban region. The North Buffalo sludge incinerator is the only significant source of air pollutants at the treatment plants, but its impact is mitigated by extremely efficient wet scrubbers.

No community-wide odor problems exist in the study area. The existing wastewater treatment plants are recognized as sources of odor nuisance to areas surrounding the plants.

The Greensboro area has a noise climate typical of similar metropolitan areas in the United States. Residential areas are characterized by low to moderate levels permitting, in most areas, pursuit of outdoor activites without interference from intruding noise. Zones of higher noise level are near major traffic

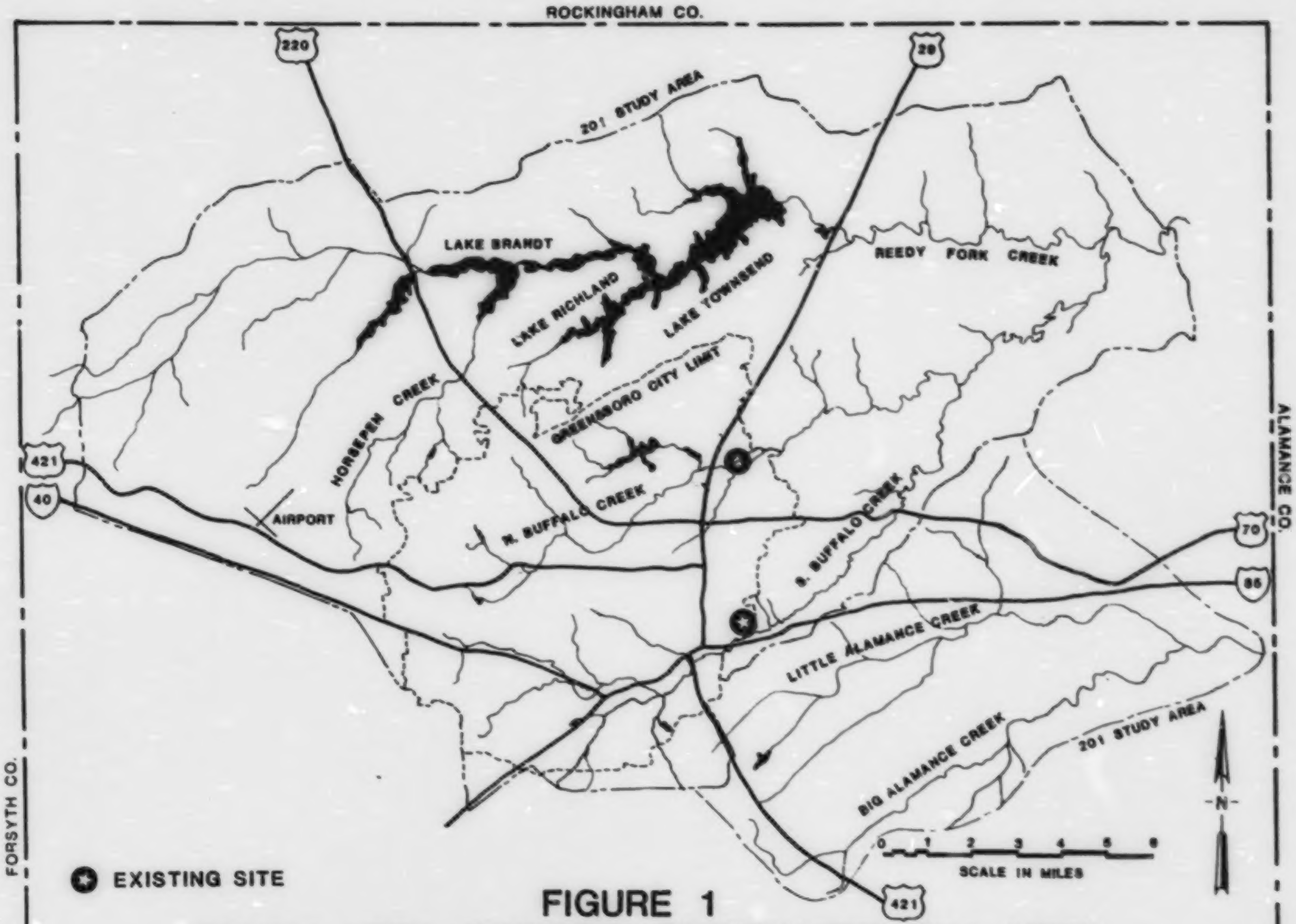

ROCKINGHAM CO.
ALAMANCE CO.
FORSYTH CO.
220
29
421
40
70
85
421
201 STUDY AREA
LAKE BRANDT
LAKE RICHLAND
LAKE TOWNSEND
REEDY FORK CREEK
GREENSBORO CITY LIMIT
HORSEPEN CREEK
AIRPORT
N. BUFFALO CREEK
S. BUFFALO CREEK
LITTLE ALAMANCE CREEK
BIG ALAMANCE CREEK
201 STUDY AREA
N
0 1 2 3 4 5 6
SCALE IN MILES
EXISTING SITE

FIGURE 1
STUDY AREA SHOWING DESIGNATED 201 AREA
AND EXISTING WASTEWATER TREATMENT FACILITIES

arteries and the airport. Noise radiated from existing wastewater treatment plants is of a level too low to be detectable by people living around the plants.

The topography of Guilford County is typical of the Piedmont Plateau physiographic province in that it is gently rolling in the uplands and somewhat more rugged near the major streams. The bedrock of the county consists of igneous and metamorphic rocks that are also typical of the Piedmont province. The bedrock is overlain by a thick mantle of saprolite (soft, weathered bedrock) in most of the county. The most important geologic processes are ground-water recharge and flooding.

The soils of Guilford County comprise deep, well-horizonated acid soils on the uplands and poorly-horizonated alluvial soils along creek bottoms. A total of seven soil associations have been recognized and mapped in the county. Nearly all of the soils are poorly suited for septic tank use, primarily because of low permeability in the subsoil horizon. All of the soils except those along bottomlands are also poorly suited for land application of sewage effluent.

Streams of the study area are numerous and rather small, especially those reaches draining the immediate area of metropolitan Greensboro. The 7-day, 10-year low flows for these streams are only a few cfs or less, although average discharges are considerably larger. Two streams, North and South Buffalo Creeks, are significantly degraded in quality by municipal and industrial outfalls and, increasingly, non-point source pollutants in urban land runoff. Most industrial wastewater is discharged directly or indirectly to South Buffalo Creek. Malfunctioning septic tanks have caused locally poor bacteriological quality in streams throughout the area. The water supply for Greensboro is provided by a system of small reservoirs, north of the city, upon which urbanization is now encroaching.

Because of the geologic setting of Guilford County, major regional aquifers do not exist. Shallow, low-productivity water-table aquifers are present, however, and serve as important water sources in rural areas. The ground water of these aquifers occurs in pore spaces in the saprolite and in fractures in the underlying bedrock. Recharge to the aquifers occurs in the uplands, and discharge is to wells or as baseflow to the streams. The total ground water available in the county is estimated to be about 150 MGD, but only approximately 11 MGD is presently being used. Ground-water quality is generally good, except for a high iron content in some areas. Ground-water quality problems from septic tanks have been reported in the county.

The potential natural vegetation in the Greensboro area is a climax hardwood forest. Man's use of the area has resulted in the establishment of a mixed oak-hickory-pine forest type which is now fragmented by cultivated fields, old fields, and urban areas. No virgin woodlands remain. About half of the total rural land in the study area is forested with second growth woodlands in various stages of succession.

Because man's use of the study area has fragmented the natural vegetation, forest species have decreased while species preferring brushy habitats have increased. Small game animals and game birds have benefitted from fragmentation of the woodlands. Other game animals such as whitetail deer and wild turkey have been pratically eliminated. Species tolerant of or especially adapted to man's alterations in natural conditions are generally characteristic of the area's fauna.

Aquatic plants in the Greensboro area are almost entirely restricted to streams and lakes above the existing sewage treatment plants. Small, localized colonies of green and blue-green algae may be found in North and South Buffalo Creeks below the treatment plants where suitable, stable substrates exist. Benthic invertebrates are most numerous and diverse in Horsepen Creek, Alamance Creek, and Reedy Fork. Most sport fishing is restricted to Alamance Creek, Reedy Fork, Lake Brandt, and small farm ponds. Both North and South Buffalo Creeks contain benthic invertebrates tolerant of heavy pollution and very few, if any, game fish.

No virgin woodland stands remain in the study area. Three plant species are listed as "threatened throughout" their range in North Carolina. The southern rain orchid (*Habenaria flava*), Nestronia (*Nestronia umbellula*), and ginseng are all moist lowland species. None of the mammals of Guilford County are considered endangered. The Bald Eagle once nested in the area and the Peregrine Falcone migrates through the region. Both are considered endangered by the U.S. Fish and Wildlife Service. The sharp-shinned hawk is considered threatened and is reported to nest near Lake Brandt. Species which are sensitive in the area because they are relictual populations or occur at the edge of their range include the white-crowned sparrow, crescent shiner, and an unidentified species of freshwater clam.

b. Man-Made Environment

The EIS Study Area had 196,617 people in 1975 and will grow to 287,200 by the year 2000. This population is clustered in Greensboro itself with a few small high-density settlements on the periphery along transportation arteries. Racially, the area is 25 percent black with 64 percent of the blacks in the South Buffalo subbasin and 28 percent in the North Buffalo subbasin.

The age of the population is young (median age of 27.0) relative to the U.S. (28.1). Median income in 1970 was high relative to both the state and the U.S.

The Greensboro area economy has grown since 1970 with 20,000 jobs created in Guilford County from 1970 to 1974. Unemployment has been low in recent years (normally under 4 percent). Manufacturing dominates the employment structure with textile employment being conspicuously important. Employment in manufacturing sectors such as wholesale/retail trade and services has grown in recent years.

As one would expect, residential land predominates within Greensboro with commercial land uses interspersed, especially in the CBD and along major thoroughfares. Industry is closely linked to transportation and dominates areas along highways, near railroads, and close to the airport. Forests and agriculture predominate in the periphery of the study area with residential areas along highways and at intersections. Future land use will feature growth all around Greensboro with no directional bias being dominant. Highway access will be an important determinant of growth patterns.

Greensboro and Guilford County are providing police and fire protection, health care, education, waste disposal, libraries, and other public services that are essential. Wastewater treatment is less than perfect and should be corrected by this proposed action.

Greensboro and Guilford County are financially sound governments paying for their needs with very little bonding required.

The Guilford County area has a rich cultural heritage which is being enhanced and protected. National Register historic sites are located in Greensboro and many buildings and areas of historic value have been identified. Also, the area may have archaeological resources, but they are not well known at this time. Recreational resources are scattered throughout the city and county.

As a focal point of North Carolina highways, Greensboro's major thoroughfares are heavily used. Thoroughfares are planned to relieve excess traffic loads as they develop, especially in peripheral areas.

Duke Power Company will be able to meet the area's energy requirements through the year 2000 as long as coal and nuclear power are available. No major natural resources are being extracted in the study area other than rock and gravel.

2. System Alternatives

To satisfy a 20-year growth projection requiring 36 million gallons per day (MGD) of treated wastewater, 124 alternatives entailing consideration of 14 different treatment plant sites located in five major watersheds were identified. These alternatives were tested in a multilevel screening process involving environmental, engineering, legal and cost constraints, and inputs from the Greensboro EIS Advisory Committee. With this process, the alternatives were reduced to a total number of seven, including No Action, for evaluation in this Draft EIS. All alternatives considered require the upgrading of the existing North Buffalo treatment plant (NBP) to provide a tertiary level of treatment at 16.0 MGD. All alternatives, except No Action and Alternative 6, call for a 20 MGD plant with tertiary treatment on either South Buffalo or Buffalo Creeks. The alternatives receiving detailed environmental, cost, and engineering analysis are summarized below. The alternatives are depicted graphically in Figures 2 and 3.

Alternative 1 - NBP plus upgrading and expanding existing South Buffalo Plant (SBP); construction of an outfall/force main from existing SBP to Highway 70.

Alternative 2 - NBP plus abandonment of SBP and construction of a new plant 14,000 feet downstream from the SBP; construction of an outfall sewer from SBP to the new plant location; construct an outfall/force main from the new plant site to Highway 70.

Alternative 3 - NBP plus abandonment of SBP; construction of a new plant 26,000 feet downstream of SBP; construct an outfall sewer from SBP to new plant site.

Alternative 4 - NBP plus abandonment of SBP; construction of a new plant on Buffalo Creek 46,500 feet downstream of SBP; construction of an outfall sewer from SBP to new site.

Alternative 5 - NBP plus abandonment of SBP; construction of a new plant 66,500 feet downstream on Buffalo Creek; construction of an outfall sewer from SBP to new site; construction of an outfall sewer from new site to Reedy Fork Creek.

Alternative 6 - NBP plus expand NBP to 25 MGD in 1987; upgrading SBP to tertiary level of treatment at 11.0 MGD; construction of a pump station and force main from SBP to NBP to transfer 9.0 MGD; construction of an outfall/force main from SBP to Highway 70.

Alternative 7 - No Action; upgrade NBP and SBP to tertiary level of treatment at existing capacity; provide septic tanks to additional households not provided sewer service.

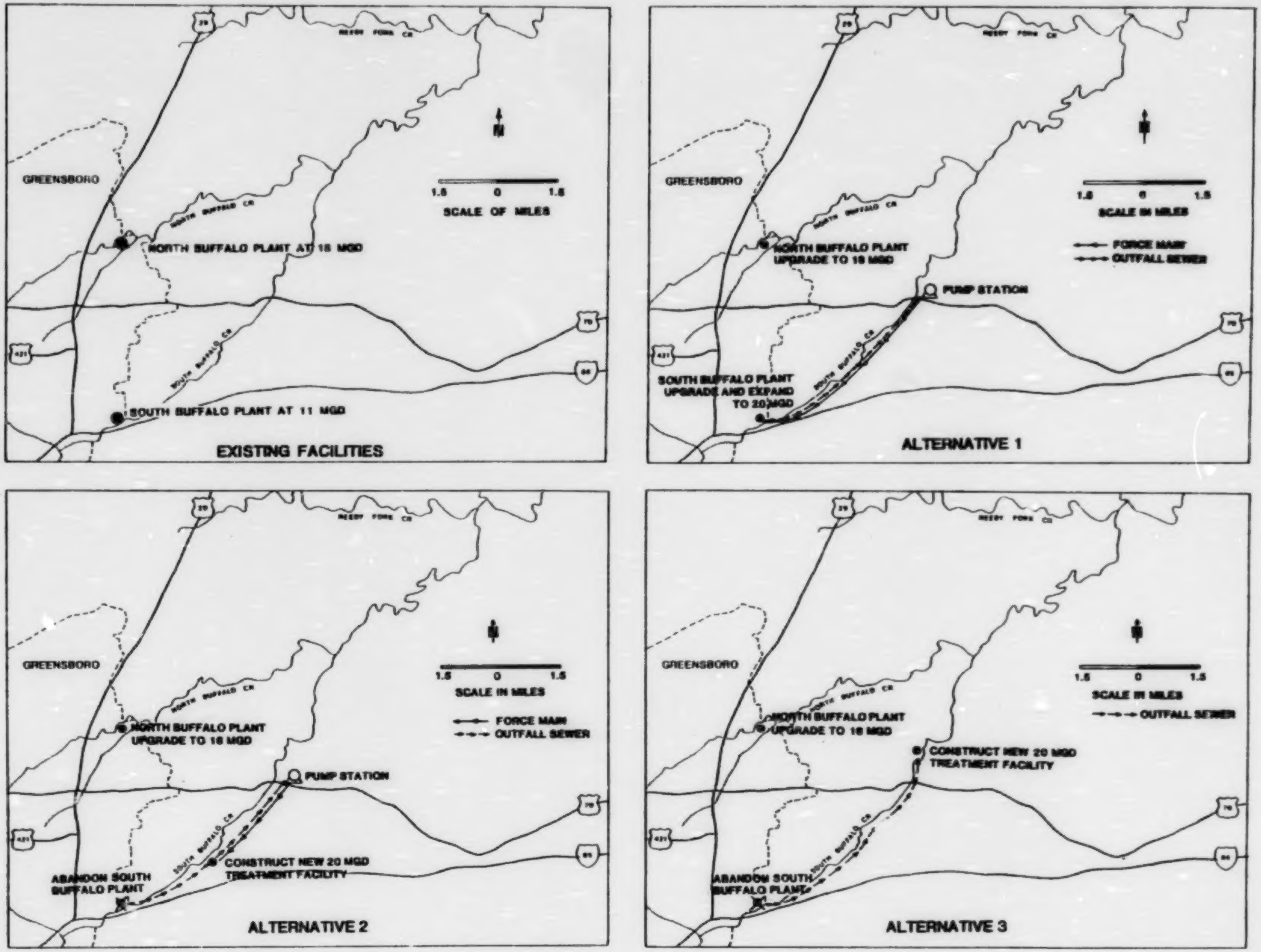

GREENSBORO
REEDY FORK CR
NORTH BUFFALO CR
SOUTH BUFFALO CR
29
421
70
85
N
1.5 0 1.5
SCALE OF MILES
NORTH BUFFALO PLANT AT 16 MGD
SOUTH BUFFALO PLANT AT 11 MGD
EXISTING FACILITIES
SCALE IN MILES
FORCE MAIN
OUTFALL SEWER
NORTH BUFFALO PLANT
UPGRADE TO 16 MGD
PUMP STATION
SOUTH BUFFALO PLANT
UPGRADE AND EXPAND
TO 20 MGD
ALTERNATIVE 1
CONSTRUCT NEW 20 MGD
TREATMENT FACILITY
ABANDON SOUTH
BUFFALO PLANT
ALTERNATIVE 2
ALTERNATIVE 3

FIGURE 2

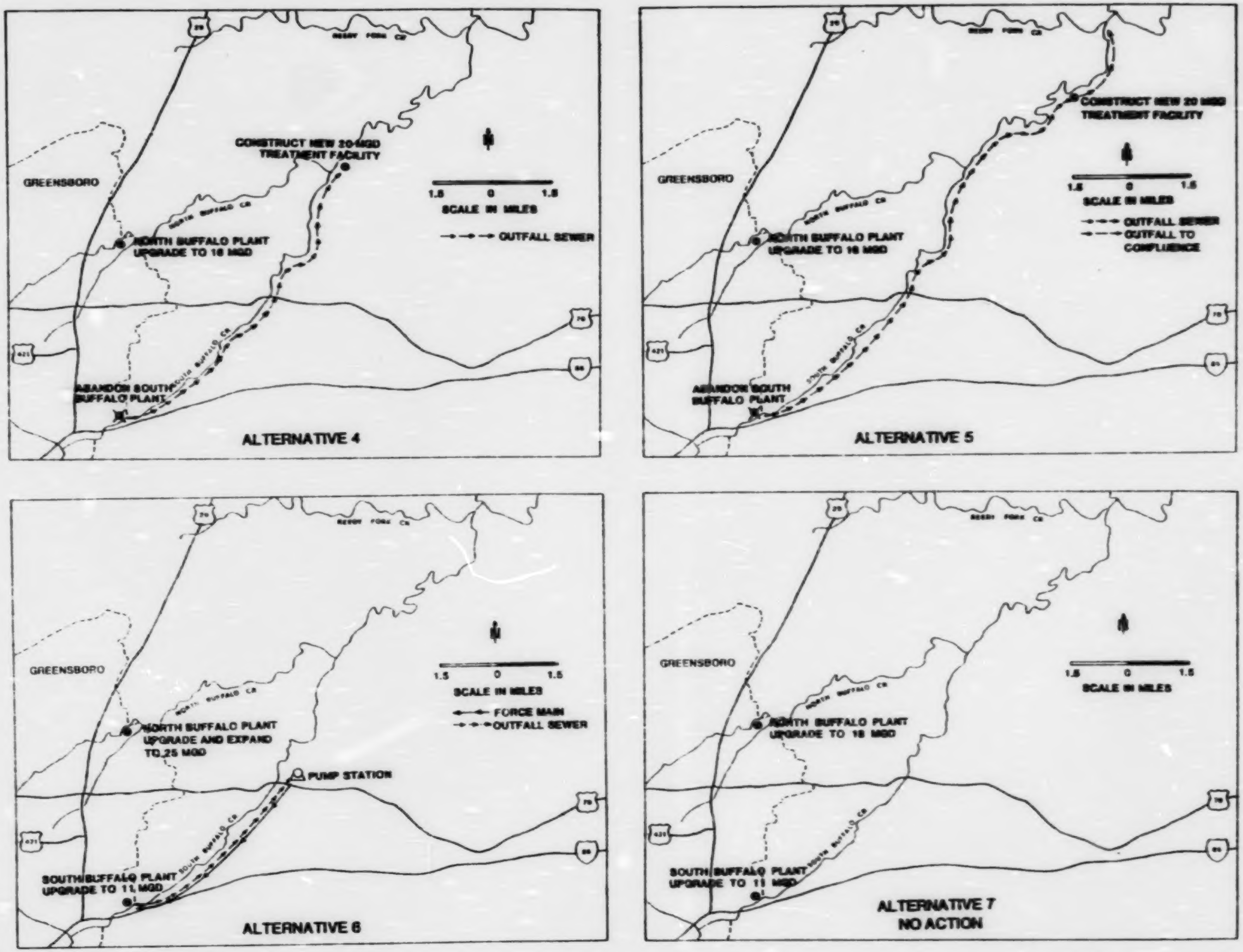

GREENSBORO
REEDY FORK CR
NORTH BUFFALO CR
SOUTH BUFFALO CR
CONSTRUCT NEW 20 MGD TREATMENT FACILITY
NORTH BUFFALO PLANT UPGRADE TO 16 MGD
ABANDON SOUTH BUFFALO PLANT
1.5 0 1.5
SCALE IN MILES
OUTFALL SEWER
ALTERNATIVE 4
OUTFALL TO CONFLUENCE
ALTERNATIVE 5
NORTH BUFFALO PLANT UPGRADE AND EXPAND TO 25 MGD
PUMP STATION
SOUTH BUFFALO PLANT UPGRADE TO 11 MGD
FORCE MAIN
ALTERNATIVE 6
ALTERNATIVE 7
NO ACTION
29
421
70
85

FIGURE 3

3. Description of the Proposed Action

The proposed action for wastewater treatment facility improvements for Greensboro-Guilford County is Alternative 3 and is comprised of:

- making maximum use of NBP by upgrading to provide tertiary treatment at 16 MGD
- abandonment of SBP
- construction of a new $1,400,000 plant on South Buffalo Creek about 26,000 feet downstream of SBP to provide tertiary treatment at 20 MGD
- construction of a new sixty-inch outfall sewer from SBP to the new plant site.

4. Environmental Effects of the Proposed Action

a. Natural Environment

Direct air quality impacts of the proposed action will occur during the construction and operation phases. During construction at the new South Buffalo site, appreciable fugitive dust may be generated. These emissions should have a localized impact. Operational impacts include combustion products from gas and diesel-fueled engines used to produce power and also from the sludge incinerator. The incinerator emissions will be minor because of adequate control equipment. Secondary impacts will occur due to growth patterns in the study area. More human activity will bring about more air pollutant emissions. It is not known whether this will cause any future violations of air quality standards.

Odor impacts will occur due to the upgrading and expansion of existing wastewater treatment plants. Replacement of the existing South Buffalo plant with a new plant downstream will have a beneficial impact to the population surrounding the existing plant. No adverse impact should occur from the new plant due to the low population density within one mile of the site. No substantial reduction in odor impacts will result from the proposed upgrading of the North Buffalo plant.

Noise generated by construction of the South Buffalo interceptor may cause disturbance to outdoor activities for persons living or active within 2000 feet of the construction activity. Any one area is not expected to be affected for a period of more than one month. Construction and upgrading of the treatment plants is not expected to generate adverse reaction to noise. Noise from operation of the South Buffalo plant will not cause an adverse impact on area residents. Operation of the North Buffalo plant may cause slight annoyance to people engaged in outdoor activities especially during nighttime hours.

The primary geology-related environmental effect will be the blasting that will likely be necessary both for the new sewage treatment plant and for the new pipeline that will connect the new plant with the existing South Buffalo plant.

Two soils-related impacts will result from the proposed action. Approximately 40 acres of moderately productive soil will be permanently removed from cultivation by the new treatment plant, and the moderately high erosion susceptibility of the soil will probably result in considerable erosion at the site during construction.

The direct effects of the proposed action on the water regime are small. Streamflow, especially dry weather flows, will gradually increase below the outfalls as a result of increased municipal wastewater and will promote a small incremental amount of continuing streambank erosion and siltation. Sewer emplacement is likely to be more consequential for stream siltation, but this impact will be temporary and minor. Removal of the existing municipal wastewater discharge for five miles of South Buffalo Creek will significantly improve water quality in that reach only if upstream industrial discharges are removed or undergo better treatment. Enforcement procedures are available and in effect at both state and federal levels to ensure that unacceptable discharges will be eliminated. The oxygen-demanding pollutant loads to North and South Buffalo Creeks will be substantially reduced, by 45 and 34 percent respectively, and the times that these streams experience poor quality conditions will be decreased. However, the water quality of the hydrologic system will remain in a rather highly stressed state, due to the influence of industry and urban land runoff. Perhaps only in Reedy Fork and more downstream areas will the stream health show substantial improvement as a result of the proposed wastewater treatment facilities. Increased assimilative capacity provided by the design wastewater discharge in these lower stream reaches should be beneficial to water quality during lower flows. No downstream water supply will depend upon disinfection at the proposed treatment plants for bacteriological quality although public-health hazards of the malfunctioning septic tanks in these watersheds is expected to continue in the long-term. Discharge of nutrients and residual chlorine should not impose an ecological burden. The chlorination process, however, could conceivably create very low concentrations of carcinogenic, mutagenic or otherwise toxic compounds in the effluent as a result of chemical reactions with the variety of organics in these municipal wastewaters. This is not a certain effect and has not been documented at the existing plants, but should be considered as a possible direct impact.

The indirect effects of increased urbanization on water quantity and quality are considered more significant than the direct effects. The major hydraulic effects that are likely to be experienced are substantially higher peak flows on the streams draining the urbanized area and concomitant more frequent flooding in areas downstream. An indirect result of this increased flooding is likely to be increased amounts of channelization and other hydrographic modifications that can be unaesthetic, degrade water quality, and destroy riparian habitat unless carefully planned. The continued urbanization of the region will also be responsible in large part for continuing poor quality water in the streams of the Greensboro area. The point-source discharges apparently are not capable, within the existing technological and regulatory framework, of creating a sufficiently large buffer in stream quality to accommodate the adverse effects of urban non-point source pollutants without experiencing water quality degradation. A monitoring and modeling program to quantify urban runoff effects on stream and reservoir quality in the Greensboro area is currently underway, pursuant to this EIS, and the results and recommendations for further action will be available during the preparation of the Final EIS.

The most important environmental effect of the proposed action on ground water will be the very remote hazard posed for shallow ground water at the site of the new treatment plant. Leakage and seepage from the ponds and other facilities may reach the water table without the benefit of natural renovation, particularly where the facilities are excavated below the soil zone.

The environmental effects of the proposed action on terrestrial flora and fauna will be largely temporary. Disturbance of plant and animal communities by construction and operation of the proposed facilities will not destroy critical habitat or deleterious numbers of wildlife. No endangered terrestrial species are known to inhabit the proposed construction sites. Indirect effects of the proposed action will result in an increase of the habitat fragmentation already observed in the area.

The effect of the construction and operation of the new facilities on aquatic plants and animals will be minimal. Existing aquatic habitat quality in North and South Buffalo Creeks is marginal. Therefore, the proposed action will have essentially no adverse impact and may produce some beneficial effects. Increases in flow will be similar to historical increases and should not produce any adverse effects not already observed. Secondary effects on the aquatic environment will stem from increases in urban runoff to both streams. No endangered aquatic species are known to inhabit affected stream segments.

b. Man-Made Environment

Very minimal changes in population size, characteristics, or distribution in the area will occur as a direct result of the proposed action. The economy will benefit by approximately $33 million as a result of construction costs. As an indirect result, the EIS Study Area will be able to accommodate projected population, industrial, and commercial expansion without the environmental and economic costs associated with sprawl which growth on septic tanks and package treatment plants would encourage.

The land lost to its existing use as a direct result of the proposed action is relatively unproductive in economic terms. The effect on neighboring land use will be minimal due to the buffer to be established. Beneficial effects are related to the closing of the existing South Buffalo plant, the cessation of low density sprawl based upon the use of package plants and septic tanks, and the implementation of controlled growth east of Greensboro.

The direct impact of the proposed action on community facilities is anticipated to be very small. Indirect impacts will occur as a result of population growth within the study area but will be spread over the planning period. Proper planning and zoning by the city and county will help provide additional community facilities and services as needs for them increase during the planning period.

Sewage treatment costs will increase to pay for the proposed action. The increase will be small and dispersed throughout the community. The increase should not cause undue hardship for residential customers.

Direct effects on historical or archaeological resources may exist. No presently known historical or archaeological resources will be affected by the project. The State of North Carolina will make the final determination. An archaeological survey will be performed prior to the Final EIS to determine the presence or absence of any unknown resources which might be affected. Indirect adverse effects are limited to an eventual need for expanded recreational resources as the growing population overuses those which now exist.

Huffine Mill Road will experience significantly heavier traffic during construction. The entire ground transportation system in the 201 Study Area will have to expand peripherally to accommodate projected growth. No major adverse impacts, either direct or indirect, have been identified.

Neither direct nor indirect adverse effects on resource use or supply can be attributed to the proposed action.

5. Unavoidable Adverse Impacts and Mitigating Measures

To reduce the amount of dust generated from construction at the new South Buffalo plant site, water or oil may be applied to unpaved access roads and other potential areas of dust generation. These measures can reduce dust approximately 50 percent.

Approved pre-treatment of sewage and proper operation and maintenance of equipment at both facilities can mitigate odor impacts. At both the North Buffalo Creek facility and the new South Buffalo plant, covers and gas scrubbers on the primary sedimentation tanks and sludge thickeners and gas scrubbers on the vacuum filters and anaerobic digesters, as appropriate, can be used to minimize odors. Additionally, pre-chlorination of raw wastewater at the existing South Buffalo plant can reduce the possibility of odors associated with septic sewage arriving at the new plant.

Measures designed to mitigate adverse noise impacts include properly maintaining and efficiently muffling dozers, backhoes, and cranes and reducing rock drill noise by acoustic mufflers, as well as enclosure of motors, pumps, and control valves and acoustical lagging of aboveground high pressure piping.

The blasting that will be required for construction of some of the facilities will be of short duration, so no mitigating measures will be required. The geology of the area is generally conducive to urbanization, so no mitigative measures are recommended.

Preventive measures for soil erosion and the resulting sediment generation at construction sites should be instituted as construction proceeds. These measures are summarized in the water quality section of this Summary. A possible mitigative measure for the impact of removing the 40 acres from potential cropland use, would be to put presently nonproductive land (such as a forested area) into production. However, the annual changes in agricultural land use in the region probably overshadow the localized effect of the loss of 40 acres. This mitigative measure is thus unnecessary.

The secondary effects of increased flooding as a result of urbanization can be appreciably reduced by adopting a comprehensive storm water management program that is integrated with community land use planning and engineering constraints. Reduction of impervious areas through lot size control and use of permeable pavements and structural measures to offset decreased lag times, such as detention ponds, natural and artificial depression storage, and effective routing of storm water should be considered in various critical areas.

All construction sites will be required to implement erosion and sediment control plans to mitigate or eliminate stream siltation. Other direct and indirect water quality effects can be mitigated by implementing a timely, adequate monitoring program for both effluents and receiving streams, in order to identify areas requiring preventive measures. Such measures are likely to include actions to reduce the amount and variety of contaminants accumulated on impervious surfaces, to reduce overland and channel flow velocities, and to encourage proper septic tank siting and maintenance.

A mitigative measure for the potential reduction of ground-water quality would be to ensure prevention of leakage from any of the new treatment plant facilities or the associated pipeline. Monitor wells, particularly between the new treatment plant and South Buffalo Creek, could be installed to detect ground water pollution, if it occurs, at an early stage.

Because of the historical use by man of both terrestrial and aquatic communities in the Greensboro area, no lasting adverse impacts on area biota are anticipated. Secondary environmental effects caused by urbanization would occur with or without the proposed action.

b. Man-Made Environment

Adverse impacts directly related to the proposed action are limited to traffic increases on Huffine Mill Road and minor land use conflicts at the new South Buffalo plant. The former problem is relieved by adequate scheduling while the latter is diminished by a large buffer zone.

Indirect adverse effects related to population growth may be discernible in undesirable spatial patterns of residential development or in overburdened community services and facilities. For both potentialities, farsighted planning by the county and city governments will minimize the effects.

I. INTRODUCTION

The decision-making process described in this environmental impact statement is founded on both legislative and local historical bases. A summary of this framework in which the assessment has been conducted serves as the introduction for the document.

A. Legislative and Legal Aspects

All agencies of the federal government and the State of North Carolina are required by law* to prepare a detailed environmental impact statement (EIS) for major legislative and administrative actions significantly affecting the quality of human environment. The objectives of implementing the EIS process are to (1) build into the decision-making process an appropriate and careful consideration of all environmental aspects of proposed actions, (2) explain potential environmental effects of proposed actions and their alternatives for public understanding, (3) avoid or minimize adverse effects of proposed actions, and (4) restore or enhance the quality of the environment as much as possible.

The North Carolina Department of Natural and Economic Resources in concert with the Environmental Protection Agency determined that the issuance of federal and state funds for improvements to the Greensboro, North Carolina wastewater treatment facilities constitutes a major action potentially significantly affecting the quality of the human environment. Consequently, decisions were made to prepare a joint federal-state EIS, the Notice of Intent for which was released on April 5, 1976.

---

*National Environmental Policy Act of 1969 (NEPA), 16 U.S.C. 4321 et seq., as implemented by Executive Order 11514 of March 5, 1970, the Council on Environmental Quality (CEQ) Guidelines of August 1, 1973; North Carolina Environmental Policy Act of 1971 (1971 C. 1203, S.1), N. C. Gen. Stat. Ch: 113A (Cum. Supp. 1973).

Explicitly included in the EIS for the Greensboro 201 area as a result of a legal agreement were specific considerations of the environmental acceptability of the Horsepen Creek interceptor. This issue will be dealt with separately in a supplement to the Draft EIS.

B. Local Perspectives

Greensboro, North Carolina, is located within the headwaters of tributaries of the Deep and Haw Rivers, generally draining to the east. While these local streams are small, they are presently bearing a substantial pollutant load imposed by Greensboro's significantly growing population and expanding industrial base and by its urbanizing land area. Although a restricted but underdeveloped ground water resource is available, especially for rural use, most of the population in the area depends upon surface water supplies, largely provided by a reservoir system just north of the city. The safe yield of these reservoirs is not large and will be strained to meet water demands during critical periods within the timeframe of this assessment. In addition, the quality of the water supply reservoirs is threatened by increasing urban and suburban development within their watersheds, particularly drainage areas west and north of the Greensboro central business district.

Greensboro is currently served by two wastewater treatment plants located on North and South Buffalo Creeks which drain most of the urban area. Neither plant is now maintaining the water quality of the receiving stream, although neither is currently hydraulically overloaded. The South Buffalo plant has about the same hydraulic loading as the other plant but receives most of the industrial wastewater discharged to the municipal system. Most of the direct industrial discharge to surface streams also enters South Buffalo Creek. Both of these streams are now grossly polluted from industrial and especially municipal discharges.

The City of Greensboro, North Carolina, therefore, is applying for federal EPA and state funds to expand and improve its wastewater treatment facilities. The principal objectives of this proposal are (1) to provide adequate, timely wastewater treatment facilities for the city and its service area, (2) to achieve promulgated state and federal water quality stipulations, and (3) to accommodate both domestic and industrial growth in an orderly, beneficial fashion.

More than one hundred wastewater treatment alternatives for the attainment of these objectives were initially considered. These were mutually developed by EPA, the State of North Carolina, the City of Greensboro, their consultants, and interested citizens. These options were progressively screened by applying increasingly more stringent environmental and economic selection criteria. Seven selected alternatives, including the No Action alternative, were evaluated in detail as to their environmental acceptability and cost, and one alternative comprising an environmentally sound, implementable, and cost-effective option was selected as the proposed action. The proposed action considered in this Draft EIS comprises an upgrading of the North Buffalo plant at its present design capacity of 16 MGD, construction of a new wastewater treatment plant on South Buffalo Creek about five miles downstream of the existing plant on that stream, abandonment of the existing South Buffalo plant, and expanded wastewater treatment transmission lines. The general locations of these proposed facilities are presented in Figure 2, Alternative 3, in the preceding Summary.

The total project costs for the alternative, including treatment plants, major interceptors and collectors, pumping stations, force mains, engineering, legal, and contingency services, and purchase of additional land is approximately $32,100,000. Nearly all of this amount, $32,000,000, is eligible for funding assistance by EPA and state grants. EPA will provide 75 percent, of $24,000,000, and the State of North Carolina may contribute $4,000,000, or 12.5%, for this sytem. The city's share will, therefore, be approximately $4,100,000 in capital costs. The total user cost, including amortized capital, operating, and maintenance expenses, will be $37.00 per year per user in the design year of 2000.

C. Project History

A chronological presentation of the project history and major events leading to the proposed action is provided below:

October, 1969	Greensboro retained Hazen and Sawyer Environmental Engineers to review needs at South Buffalo and the overall waste treatment program.
April, 1970	Report received from engineers on South Buffalo Creek and treatment plant.
October, 1970	Greensboro filed application for upgrading South Buffalo under PL 660. South Buffalo site approved for upgrading. Project certified for priority.
November, 1970	Greensboro voters passed $3,500,000 bond issue to upgrade outfalls, upgrade South Buffalo, and construct an outfall down South Buffalo Creek to confluence with North Buffalo Creek.
December, 1970	Engineers engaged to design South Buffalo improvements. City was notified that South Buffalo improvements were endorsed by the Piedmont Triad Council of Governments.
February, 1971	Greensboro receives offer of Federal Grant from EPA.
March, 1971	State upgraded stream requiring greater treatment.
August, 1971	Engineers directed to look at overall waste treatment picture in light of pending Clean Water Bond Act scheduled for referendum in 1972.

October, 1971	Phosphorus removal studies contracted.
December, 1971	Engineers commissioned to prepare a report on Metro Sewage System. Construction schedule adopted by City Council.
January, 1972	Application filed with Office of Water and Air Resources (OWAR) for Metro Plant, South Buffalo outfall, and improvements to North Buffalo.
March, 1972	Report on Metro Sewage System submitted. The report proposed upgrading of North Buffalo, upgrading of South Buffalo, construction of outfall down South Buffalo Creek, and construction of a new pollution control plant.
April, 1972	Metro Project given favorable review by Piedmond Triad Council.
May, 1972	State Clean Water Bond Act passed.
July, 1972	EPA questions advisability of keeping South Buffalo Plant with advent of new Metro Plant. Requested economic evaluation of three plant proposal.
August, 1972	Site inspection of the South Buffalo Plant made by OWAR. State, federal, and city officials met in Raleigh to discuss the South Buffalo and Metro Plants.
September, 1972	Greensboro City Council requested increase in grant for South Buffalo from 33% to 55%. EPA advised Greensboro not to proceed with the improvements at South Buffalo until they could evaluate the economics of the three plant concept.
October, 1972	Greensboro City Council adopted new time schedule for waste treatment improvements due to delays. EPA withdrew objections on the three plant concept and authorized funding for the project. Federal Water Pollution Control Act Amendments of 1972 passed by Congress. The elements of this required that a Facilities Report, Environmental Assessment, and an Infiltration/Inflow Analysis be prepared.

January, 1973	Bids on work for South Buffalo received. Pilot work began to determine best practical technology for design of Metro Plant.
March, 1973	Contracts awarded for South Buffalo improvements.
April, 1973	Site at confluence of Buffalo Creeks approved by OWAR.
June, 1973	Informational meeting held at Piedmont Triad Council of Governments in which McLeansville residents voiced objections to site. At this meeting it was publically proposed that a site on Alamance Creek be selected or that the present site at South Buffalo be drastically expanded. Engineers directed to prepare Facilities Report, Environmental Assessment, and Infiltration/Inflow Analysis as per EPA guidelines of PL 95-500 and to consider all possible alternatives.
July, 1973	City requested delineation of 201 Planning Area from OWAR.
November, 1973	Greensboro and Guilford County Governments passed resolution making City responsible for treatment of waste but put all facility planning on a joint and cooperative basis. Metro Greensboro given number one priority in state.
January, 1974	Copies of Facilities Report, Environmental Assessment, and Infiltration/Inflow Analysis distributed to EPA, OWAR, units of local government, and other interest groups and individuals.
February, 1974	Public Hearing on Metro held. OWAR encouraged city to proceed on 201 plan.
June, 1974	City submitted Facilities Report to OWAR.
August, 1974	Representatives of McLeansville proposed Ivey Dairy Farm as alternate site. City directed consultants to study newly proposed site and also two sites just upstream of the confluence.
January, 1975	Division of Environmental Management issued public notice of intent to issue permit for Metro site.

March, 1975	Permit to discharge from Metro site issued.
April, 1975	Fifth Public Hearing held on Metro.
September, 1975	Conference held in Raleigh on 201 Facilities Report.
October, 1975	Conference held in Raleigh on 201 Facilities Report.
April, 1976	Notice of Intent to prepare a joint federal-state EIS for Greensboro's wastewater management system.
September, 1976	Radian Corporation was contracted to assist EPA and the State of North Carolina in preparation of the EIS
November, 1976	Public meeting was held to present purpose of EIS and obtain public input.
November-June, 1977	Identification of viable wastewater management alternatives; screening most promising systems with environmental, cost, legal, social, and engineering constraints.
June, 1977	Selection of proposed action.

II. DESCRIPTION OF THE EXISTING ENVIRONMENT

The total environment is a dynamic and interlocking system which may be broken arbitrarily into logical divisions for examination and analysis. It must be borne in mind, however, that the division being investigated is not functionally separated from the total environment.

The existing environment of the study area is divided into the natural environment and the man-made environment. The natural environment may be regarded as those things which are external to, but which influence and are influenced by, man's social structures. Conversely, the man-made environment may be regarded as those things present in the environment which are the products of man and his social structures, for example, demography, economics, and economic geography.

The existing environment has been described in this chapter primarily at a regional level, to set the context for interdisciplinary evaluation of alternative treatment systems. Some site-specific detail has been added where possible and appropriate for the environmental assessment. The level of detail in the Draft EIS is limited both by the amount of reliable information that exists and by the relevancy of inclusion to the impact evaluations. Part of the additional information that has been considered in the professional evaluation but which has been judged too peripheral or too detailed for general consideration is included in the Technical Reference Document (RA-R-406).

A. Natural Environment

1. Physical Components

a. Climate

Greensboro, in Guilford County, is located in the gently rolling northern Piedmont section of North Carolina. The climate of the area can be typed as humid subtropical. This type of climate is characterized by relatively short, mild winters and long, hot summers. Rainfall is abundant, but only a few snowfalls occur each winter (CL-093).

(1) Temperature

The average annual temperature at Greensboro is $58.2^{\circ}F$, with an average daily maximum temperature of $69.3^{\circ}F$ and an average daily minimum temperature of $47.0^{\circ}F$.

The warmest month during the year at Greensboro is July, which has an average temperature of $77.3^{\circ}F$. Summer temperatures of $90^{\circ}F$ or above are not unusual during the period from June through August. A few days of $90^{\circ}F$ temperatures may also occur during April, May, and September.

The coolest month of the year at Greensboro is January, which has an average temperature of $39.7^{\circ}F$. Minimum temperatures of $32^{\circ}F$ or below are quite common during winter months and also may occur during late fall and early spring.

(2) Precipitation

The average annual precipitation at Greensboro is 42.16 inches. The wettest month during the year is July, when an average of 4.79 inches of precipitation is recorded. The driest month is November, when the monthly average precipitation is 2.68 inches. During the summer months, precipitation occurs primarily as scattered showers and thundershowers. During the winter months, however, precipitation occurs primarily as steady, widespread rainfall. Therefore, precipitation amounts during the winter are more evenly distributed than during the summer.

The average annual snowfall in the Greensboro area is 8.8 inches, but the total during any given year is quite variable. The Greensboro area experiences an average of only two days during the year with one inch or more of snowfall or ice (NA-166).

(3) Relative Humidity

Relative humidities in the Greensboro area average about 71 percent during the year. The most humid months are July and August, both of which average about 79 percent relative humidity. The driest month is March, with an average relative humidity of 61 percent. Generally, relative humidities are highest near sunrise, when the coolest temperatures occur. Conversely, relative humidities are generally lowest in the early afternoon, when temperatures are highest (NA-166).

(4) Heavy Fog

Heavy fog (which restricts visibility to ¼-mile or less) occurs on an average of thirty-one days during the year. The frequency of occurrence of heavy fog is slightly higher during the winter months than during the rest of the year (NA-166).

(5) Wind Speed and Direction

On an annual basis, wind speeds in the Greensboro area average 7.8 mph. The windiest month during the year is March, when the average wind speed is 9.4 mpg. The least windy month is August, when the average wind speed is 6.4 mph (NA-166). The annual wind rose for Greensboro is presented in Figure II-1. The seasonality effects are weak (NA-274).

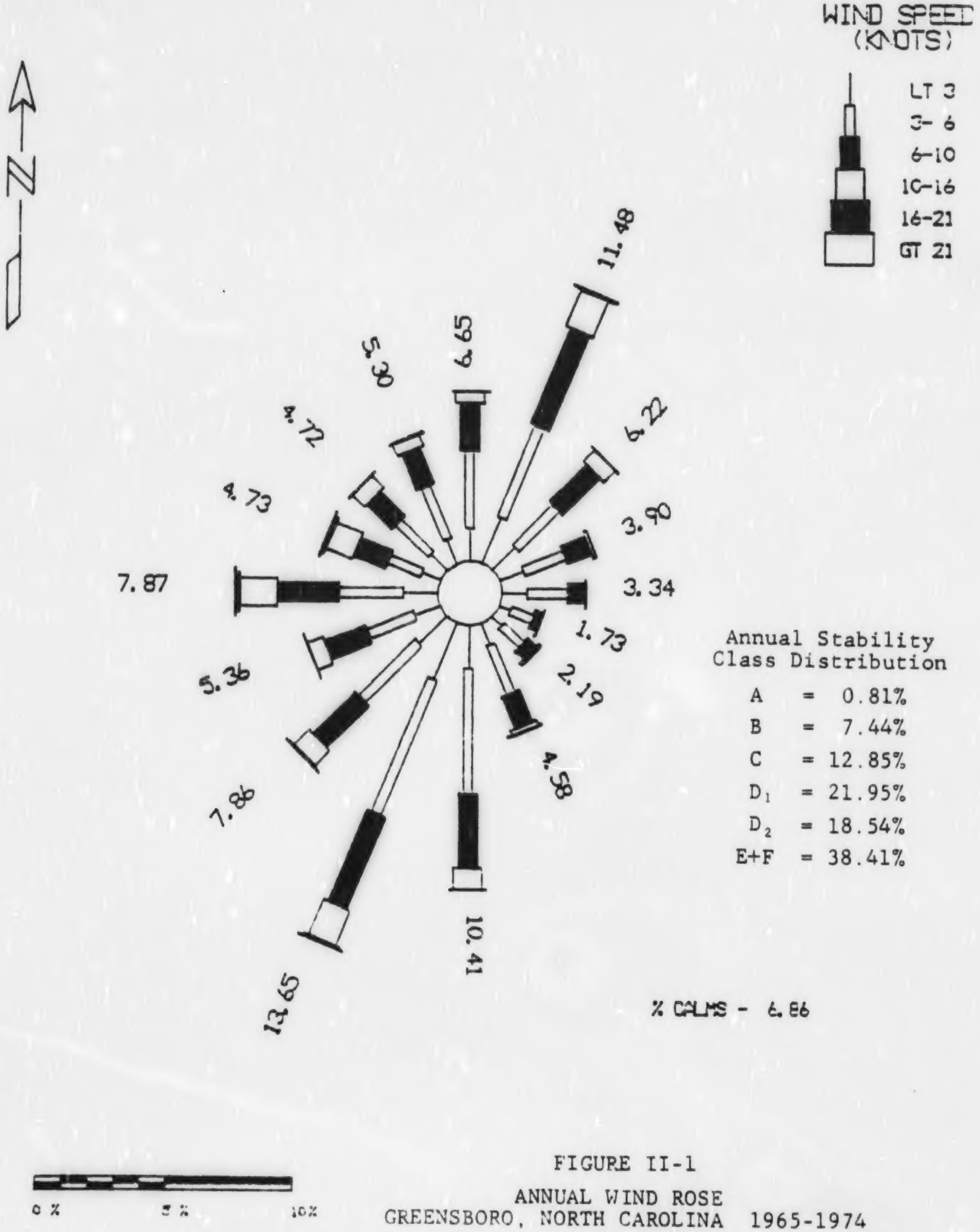
(6) Catastrophic Meteorological Events

On the average, forty-seven thunderstorm days occur during the year in the Greensboro area. The season for thunderstorms is May through August, although a few may occur during the other months of the year (NA-166). About two percent of the thunderstorms that occur in the area produce hail which reaches the ground (FL-063).

North Carolina is outside the principal tornado zone of the United States. The state experiences, on the average, only three tornadoes annually, most of which occur in the southern Piedmont region. Tornadoes most often occur in North Carolina during March, April, and May, although they may occur during any month of the year (CL-093).

Because of its distance from the Atlantic Coast, the northern Piedmont area of North Carolina is affected primarily by rainfall associated with tropical storms that achieve landfall along the North Carolina coast, on an average of about once every eight years. Hurricanes (winds of 74 mph or greater) reach the northern coastline on an average of about once every ten years, while "great hurricanes" (winds of 125 mph or higher) move inland approximately once every thirty-five years (SI-110).

"Extreme mile" winds are the strongest sustained one-minute wind speeds that can be expected to occur in a region within a certain recurrence interval, at a standard height of thirty feet above the ground. In the Greensboro area, "extreme mile" winds of 50 mph primarily caused by localized severe thunderstorms occur



Annual Stability
Class Distribution

A = 0.81%
B = 7.44%
C = 12.85%
D_1 = 21.95%
D_2 = 18.54%
E+F = 38.41%

FIGURE II-1
ANNUAL WIND ROSE
GREENSBORO, NORTH CAROLINA 1965-1974

Source: NA-274

at mean intervals of two years, and 80 mph winds of 100-year intervals. "Extreme mile" winds for various recurrence intervals are shown in the Technical Reference Document (RA-R-406).

Most flooding which occurs in the Greensboro area is localized and occurs with thunderstorm activity. Flash flooding of small streams is not uncommon with the heavier, slow-moving thunderstorms. The most extensive and damaging floods occur in association with tropical storms (NA-166).

(7) Meteorological Potential for Pollutant Dispersion and Air Stagnation

North Carolina is located in a section of the country which often experiences poor dispersion conditions due to a high frequency of low-level inversions and a tendency for high pressure systems (anticyclones) to either move slowly across or stagnate in the area. These conditions limit vertical mixing of atmospheric pollutants, which may result in significantly higher than average ambient concentrations of some pollutants.

b. Odor

This section describes odors perceived by the population in the study area. Most airborne odors are caused by some type of volatile organic or inorganic compound such as ammonia, hydrogen sulfide, etc. The perception of odors can be described quantitatively and qualitatively. Qualitative descriptions such as rancid, rotten egg, fishy, etc. are subjective.

Quantitatively, odors can be described by the concentration of the odor in the air. Im ambient air, combinations of various odors make identification and quantification difficult (CH-196). In the Greensboro study area, no quantitative odor data were available.

An alternative method of analysis involves the subjective community perception of odors in ambient air. No existing studies, such as a community odor survey, were located for the Greensboro study area. However, several sources of odor were noted during contacts with knowledgable local officials. In addition, tours of both existing sewage treatment plants were taken. David Ligon, Regional Air Quality Engineer, Winston-Salem, mentioned three industrial sources of odor in the study area. These were a fertilizer plant, a chemical plant, and rendering plant. The conditions which led to odor emissions at these plants have been improved, and odors have been reduced and/or eliminated (LI-168). Personnel of the Guilford County Public Health Department were also contacted regarding records of odor complaints; none were available (BR-359).

The existing municipal wastewater treatment plants are acknowledged to be sources of odor in the community. For a discussion of the processes which are used at these two plants, see Section II.B.8. The most significant parameter which influences community impact of odors emanating from the plants is location. The South Buffalo plant is located near a residential area (RA-R-206). The plant has caused some nuisance to citizens in that area. According to the Greensboro Public Works Department, no odor complaint records are kept by the city. Treatment plant operators attempt to reduce odors at the plant in response to complaints. The North Buffalo plant is not as close to a residential area as is the South Buffalo plant (RA-R-406). However, the North Buffalo plant has received complaints from a shopping center across North Buffalo Creek. Odor masking agents are employed to reduce odors at the North Buffalo plant. At the South Buffalo plant, gases off the primary tanks are collected and scrubbed with permanganate to reduce odors (BR-359). Odors at these plants are typical of inadequate treatment plants. Compounds such as hydrogen sulfide, ammonia, and various organics are emitted from treatment plants. Depending on the observer, these odors can be described as rancid, fecal, sour, etc. (RA-340).

c. Air Quality

This section presents a description of existing air quality in the Greensboro study area. Ambient air quality will be characterized on the basis of air sampling data from monitoring stations in Guilford County. Air pollutant emissions sources will also be presented for the county.

Ambient Air Quality

Greensboro, Guilford County, North Carolina is in the Northern Piedmont Air Quality Control Region (AQCR). In 1972 this AQCR was assigned air pollutant priorities for the development and evaluation of the state implementation plan to achieve the national ambient air quality standards (NAAQS). These priorities were based on existing air quality where known, or estimates. The AQCR was designated priority I for total suspended particulates (TSP), III for sulfur dioxide, III for nitrogen dioxide, III for carbon monoxide, and III for oxidants (hydrocarbons). Priority I regions had air quality for that pollutant generally above the national primary standards; priority III areas had air quality generally below national secondary standards (see RA-R-406). The State of North Carolina has adopted standards identical to the National Ambient Air Quality Standards (NO-112).

Recent ambient air levels have been measured for the Greensboro area. Air monitoring data have been collected for total suspended particulates, sulfur dioxide, and nitrogen dioxide. Annual averages for the three pollutants measured are presented in Table II-1. See Figure II-2 for locations of the three monitoring sites. Measured levels of sulfur dioxide and nitrogen dioxide are better than the standards. Although two sites had previously experienced violations of the TSP standard, trends have been good. In 1975, no violations of the annual primary standard occurred. In addition to the annual averages presented in Table II-1, 24-hour samples must not have violations. In 1975, the monitor at the Greensboro City Garage showed a violation by TSP because the maximum and second maximum readings were 268 and 261 $\mu g/m^3$, respectively. The State of North Carolina has determined that this site is not representative. Sources of fugitive dust neighboring the site are thought to have caused the violation. The state has recommended that the city garage data not be used to assess the attainment of the NAAQS (RO-285).

Partly because of the above violations and because of anticipated growth, the U.S. Environmental Protection Agency has designated Guilford County to be the Greensboro Air Quality Maintenance Area for particulates (40 FR 18735, April 29, 1975). This requires that an analysis be performed to determine what problems, if any, could be anticipated in future air quality up to 1985. The study has had the following results. Using a baseline study year of 1973, projections of emission sources were made for 1975, 1980, and 1985. The emissions data were then used as input to a computer model to project ambient air levels. The results were inconsistent. The predictions for 1975 showed that levels of TSP should increase; in actuality, levels decreased in 1974 and 1975 (Table II-1). The study is currently being reviewed (EN-485).

TABLE II-1

MEASURED AMBIENT AIR QUALITY

Site	Annual Average TSP ($\mu g/m^3$)*					Annual Average SO_2 ($\mu g/m^3$)**					Annual Average NO_2 ($\mu g/m^3$)***				
	1972	1973	1974	1975	Standard	1972	1973	1974	1975	Standard	1972	1973	1974	1975	Standard
002, City Garage	85	94	90	73	75	--	--	--	--	80	--	--	--	--	100
003, Davie Street and Mebane Road	104	91	84	59	75	6	11	16	11	80	18	39	60	36	100
010, Swing Road	55	47	48	49	75	--	--	--	--	80	--	--	--	--	100

---

*Geometric Mean

**Arithmetic Mean

***Since the federal reference method for this pollutant is under revision, measured values cannot be compared to the standard.

Source: RO-285

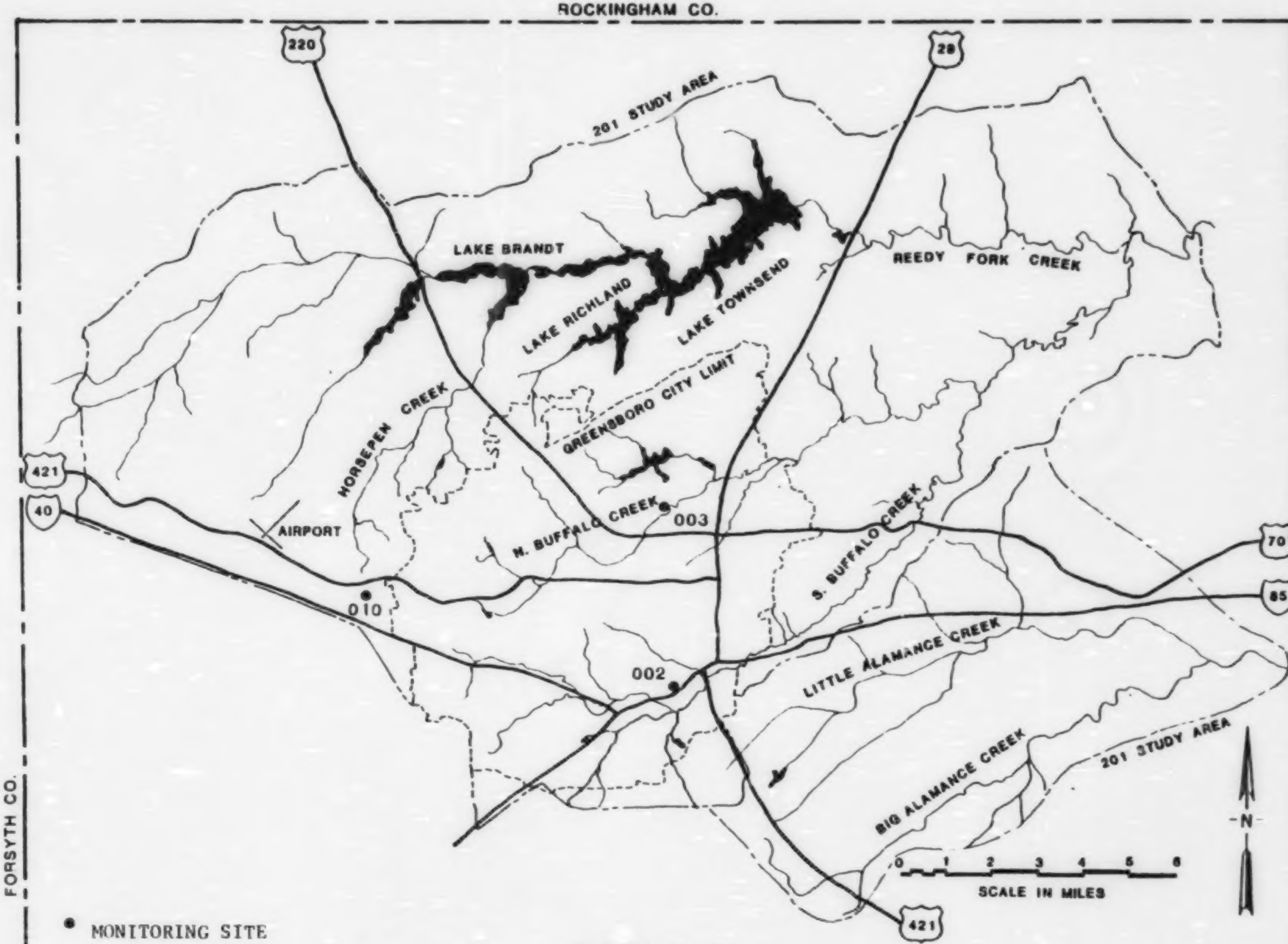

ROCKINGHAM CO.
ALAMANCE CO.
FORSYTH CO.
220
29
421
40
70
85
421
201 STUDY AREA
LAKE BRANDT
LAKE RICHLAND
LAKE TOWNSEND
REEDY FORK CREEK
GREENSBORO CITY LIMIT
HORSEPEN CREEK
AIRPORT
N. BUFFALO CREEK
003
S. BUFFALO CREEK
010
002
LITTLE ALAMANCE CREEK
BIG ALAMANCE CREEK
201 STUDY AREA
-N-
0 1 2 3 4 5 6
SCALE IN MILES
● MONITORING SITE

FIGURE II-2
GREENSBORO AMBIENT AIR MONITORING SITES

Emission Sources

Guilford County has a variety of sources of air pollutant emissions. Industrial sources are wood, paper, textiles, and chemical industries. Other sources such as highway vehicles also contribute significant tonnages of air pollutants. Unpaved roads have been shown to contribute large amounts of dust in the more rural areas of the county (EN-485). The State of North Carolina has compiled inventories of the various emission sources in the county. These data have been compiled and are presented in Table II-2. Point sources are currently defined as any stationary source which if uncontrolled would emit 100 tons per year of any criteria pollutant. Most point sources are industries. Area sources are generally smaller, more distributed sources. The data in Table II-2 were compiled at different times. Point source information is updated annually. The area source TSP inventory has been updated in conjunction with the previously mentioned AQMA analysis. A more detailed summary of TSP area sources is presented in the Technical Reference Document (RA-R-406). Vehicular travel on paved and unpaved roads is estimated to have the largest emissions (EN-485).

d. Noise

Sound level measurements within and near the North Buffalo and South Buffalo sewage treatment plants indicate that their noise fields do not significantly affect the surrounding residential neighborhoods. Although houses are located within 1000 feet of both plants, the sound is well attenuated by dense vegetation and land contours. Plant noise at neighboring homesites is inaudible or at low levels for which no adverse reaction from the community should be expected.

TABLE II-2

AIR EMISSIONS INVENTORY SUMMARY FOR GUILFORD COUNTY

	TSP	SO_2	CO	HC	NO_x
I. Fuel Combustion-Stationary Sources					
A. Area Sources	490	1,649	388	178	2,594
B. Point Sources	907	2,114	62	64	1,050
Total	1,397	3,763	450	242	3,644
II. Process Losses					
A. Area Sources	125				
B. Point Sources					
1. Chemical	30	0	0	0	0
2. Food/Agricultural	0	0	0	0	0
3. Metallurgical	40	7	36	214	11
4. Mineral Products	1,363	0	0	0	328
5. Petroleum Storage	0	0	0	26,034	0
6. Wood Products	108	0	0	41	0
Total	1,541	7	36	30,265	339
III. Solid Waste Disposal					
A. Point Sources	0	0	0	0	0
B. Area Sources	91	8	34	11	9
Total	91	8	34	11	9
IV. Fuel Combustion-Mobile Area	1,321	870	147,776	21,584	19,590
V. Dust Sources-Area	34,562	0	0	0	0
VI. Miscellaneous Area Sources	22	0	208	69	7
VII. Grand Totals					
A. Point Sources	2,448	2,121	98	27,158	1,389
B. Area Sources	36,611	2,527	148,406	25,013	22,200
Total	39,059	4,648	148,504	52,171	23,589

NOTE: TSP area source emissions are respresentative of 1975. TSP point source and other pollutant emissions are representative of 1972.

Source: NO-113, EN-485

The measured sound levels for the North Buffalo STP are listed in Table II-3. The primary acoustic sources are the pumps and compressors and the vacuum filters. The L_{dn} values in the table assume the noise level is constant throughout the 24-hour measurement period.

TABLE II-3

MEASURED SOUND LEVELS AT NORTH BUFFALO SEWAGE TREATMENT PLANT

Measurement Site No.	Level (dBA)	L_{dn}	Comments
1	50	56	Near office
2	59	65	Splashing and aeration
3	52	68	Vacuum filters
4	65	72	Pumps and compressors
5	48	54	On entrance roads
6	46	52	At White Street, plant noise faint
7	50	56	On berm toward shopping center

The measurements indicate that the radiated noise levels are high enough to cause a possible public reaction only within 300 feet of the plant edges. Since the nearest houses are 800 feet from the plant, no noise complaints should be expected.

Table II-4 summarizes the measured sound levels taken at the South Buffalo STP. The sound level measurements for the South Buffalo sewage treatment plant (RA-R-406) also indicate that no adverse community response to plant noise should occur. Although houses are located 800 feet to the west and north of the

TABLE II-4

MEASURED SOUND LEVELS AT SOUTH BUFFALO SEWAGE TREATMENT PLANT

Measurement Site No.	Level (dBA)	L_{dn}	Comments
1	68	75	Pumps
2	54	60	General plant noise
3	69	75	Splashing of surface aerators
4	55	61	Splashing of trickling filters
5	59	65	Pumps and general plant noise
6	51	57	200 feet from boundary
7	49	55	100 feet from boundary-highway noise dominating
8	48	54	250 feet from boundary-plant noise not audible

plant, the quietness of the plant and dense vegetation which attenuates acoustic waves cause negligible plant noise levels in the residential areas. Just 250 feet outside the plant boundary fence, the noise levels are sufficiently low that no complaints would be expected.

For comparative purposes, noise level measurements were also obtained in the vicinity of the Cone Mills, near 16th Street and Highway 20. The sound level varied from 58 dBA to 68 dBA. In contrast, the radiated noise is below 50 dBA at the boundaries of both treatment plants. This is 8 dB below noise at the Cone Mills boundary, which illustrates the relative quietness of the plants.

e. Geology

The information presented here is derived chiefly from previous studies of the area. Three aspects of the geology of the area are important to urbanization--the landform or topography, the geologic substrate (below the soil zone), and the geologic processes.

Topography

Guilford County is in the Piedmont Plateau physiographic province, which is a plateau primarily in the sense that it stands above the adjacent Atlantic Coastal Plain. The topography is gently rolling or undulating in the uplands, but becomes somewhat more rugged in the vicinity of the major rivers. The area is covered by the Greensboro 1:250,000 Series topographic map and most of the area is characterized by 7½-minute topographic quadrangles study (RA-R-406).

The county is located in the headwaters of the two major tributaries of the Cape Fear River--Haw River and Deep River. About 75% of the area of the county is in the Haw River basin and about 22% is drained by Deep River. The remaining 3% of the county drains in the Dan - Roanoke and the Yadkin - Pee Dee watersheds. The northeast part of the county is drained by tributaries of Haw River, and the southwest corner is drained by Deep River. The elevation extremes of the county are from about 505 feet where Alamance Creek flows out of the county to 975 feet in the extreme northwest corner of the county.

Because Guilford County is in the headwaters of Haw and Deep Rivers, no major river valleys are present. Consequently, most slopes are gentle (from 1 to 4%) in the areas between streams where the plateau surface is still preserved. Near the major tributaries, where more dissection of the plateau has occurred, the slopes are about 15 to 20%. Slopes in excess of 25% pose severe limitations for urbanization. Areas where these steep slopes occur in Guilford County are shown in Figure II-3.

Geologic Substrate

Guilford County is almost entirely underlain by igneous and metamorphic rocks of the Piedmont Province. Small parts of the county along the larger creeks are underlain by unconsolidated alluvium. The emphasis of this section is on the relatively shallow geologic substrate, which has the greatest implications for urbanization.

The bedrock of Guilford County is composed of intensely deformed metamorphic rocks that have both sedimentary and volcanic origins. These metamorphic rocks have been extensively intruded by granites and related igneous rocks. A geologic map of Guilford County and the descriptions of the map units are presented in the Technical Reference Document (RA-R-406).

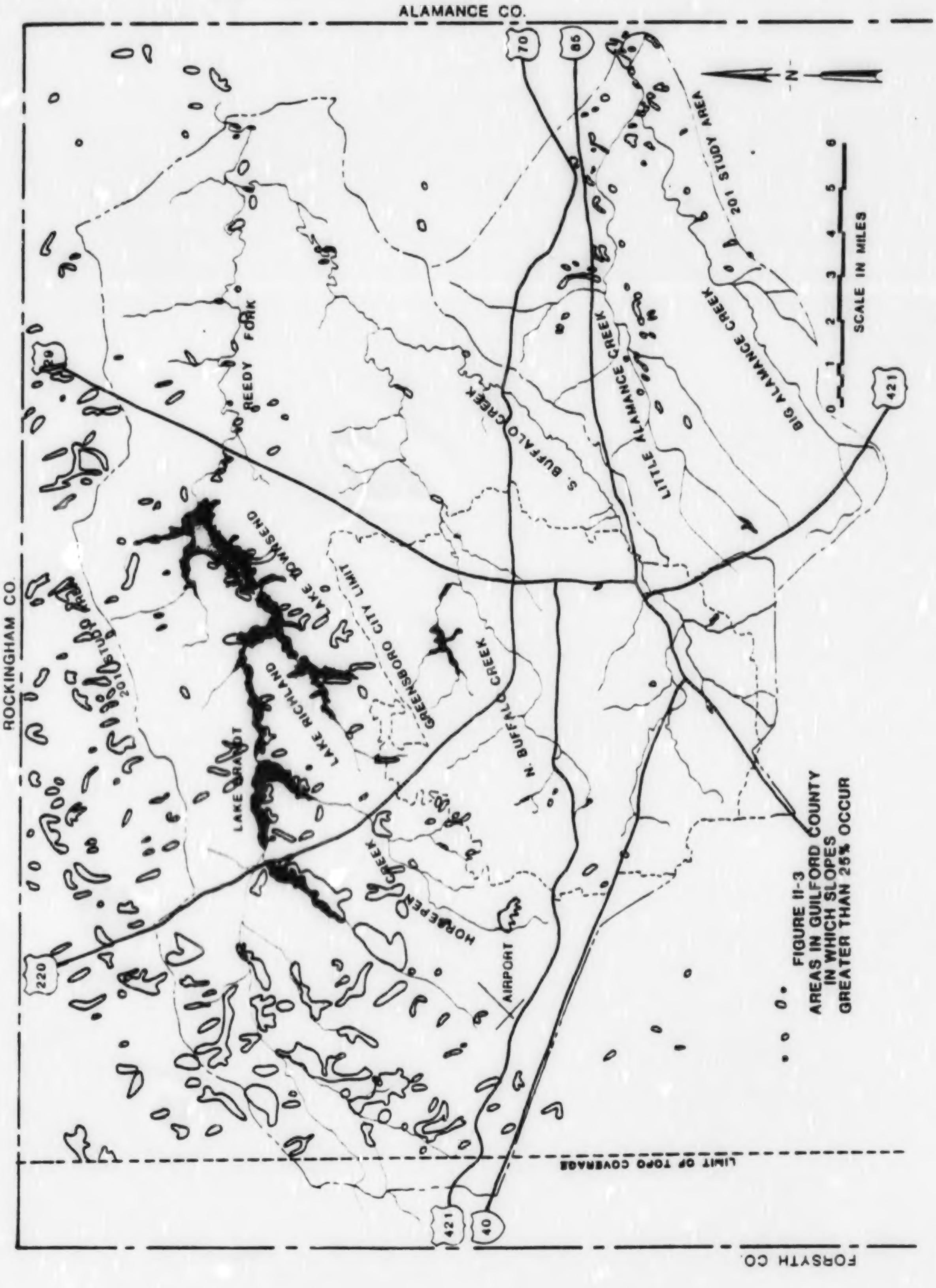

ALAMANCE CO.
ROCKINGHAM CO.
FORSYTH CO.
70
85
29
220
421
40
421
N
REEDY FORK
LAKE TOWNSEND
LAKE BRANDT
LAKE RICHLAND
GREENSBORO CITY LIMIT
N. BUFFALO CREEK
S. BUFFALO CREEK
LITTLE ALAMANCE CREEK
BIG ALAMANCE CREEK
201 STUDY AREA
201 STUDY AREA
HORSEPEN CREEK
AIRPORT
LIMIT OF TOPO COVERAGE
0 1 2 3 4 5 6
SCALE IN MILES

FIGURE II-3
AREAS IN GUILFORD COUNTY
IN WHICH SLOPES
GREATER THAN 25% OCCUR

Although the bedrock of the Guilford County area has had a long and complicated history of formation, the physical properties of the rocks are not highly variable. Thus, for example, there is not a great deal of difference in the strength or excavation potential of the diorite or granodiorite units that underlie most of the area. Of much greater importance for urbanization is the depth and degree of weathering of the bedrock. In most of Guilford County, the bedrock has been deeply weathered, leaving a thick blanket of soft residual material called saprolite. The saprolite is much softer, weaker, and easier to excavate than the bedrock from which it is derived. The thickness of the saprolite is a significant geologic parameter for urbanization. The saprolite is thickest and most extensively developed on the uplands. In Guilford County, the saprolite is from 30 to 100 feet thick on the uplands and 25 feet thick or less on the sides of the valleys. Areas north and west of Greensboro tend to have greater saprolite thickness.

Geologic Processes

The Guilford County area does not have many geologic processes that are hazardous to the works of man. No active faults are present in the county, although there is moderate risk from earthquake activity. The area is in Zone 2 of the Seismic Risk Map of the U.S.(OL-046). Where the saprolite is sufficiently thick, slopes that are oversteepened during cut and fill operations may become unstable. Areas having steep slopes, where slope failure is potentially most likely to occur, are shown in Figure II-3. Subsidence or other earth movements do not occur in the Guilford County area. The most important geologic processes for urbanization is flooding, which is described below in the section on surface-water hydrology. Another important process, aquifer recharge, is discussed in the section on ground-water hydrology.

f. Soils

The soils of the Greensboro area are of two basically different types--deep, well-horizonated, acid soils in the upland areas and alluvial soils with less well-developed horizons on the floodplains of the larger creeks. The upland soils are characteristic of the soils developed in the Piedmont Plateau, which is an old surface in an area of moderately heavy rainfall. In general, these upland soils are quite highly leached and have two well-developed layers, or horizons. The upper horizon is typically a sandy or silty loam and the lower horizon is a clay or silty clay. The upper horizon has a fairly high permeability, but the lower horizon (subsoil) is relatively impermeable. The soils are mostly developed on the deeply weathered saprolite, so the depth to hard bedrock is generally greater than 6 feet.

The alluvial soils represent the opposite end of the spectrum from the upland soils in terms of soil development. The flooding of the surfaces on which they occur causes the soils to be frequently eroded or buried, so that the soil-forming processes do not have a chance to go to completion. As a result, soil horizonation is poorly developed, and the soils are classed as entisols (soils without horizons) and inceptisols (soils with only incipient horizons).

Soil Associations

A total of seven soil associations are present in the Greensboro area. Table II-5 shows the series included in each association,[1] the approximate percentage of the county overlain by the associations, and some of the physical properties and

---

[1] The basic soil map unit now used by the Soil Conservation Service is the soil series. A soil association is composed of one or more soil series that occur in a distinctive proportional pattern.

TABLE II-5

SOIL ASSOCIATIONS OF GUILFORD COUNTY

SOIL ASSOCIATION AND % OF COUNTY INCLUDED	GENERALIZED DESCRIPTION	TOPOGRAPHIC AND BEDROCK OCCURRENCE	LAND USE	SOIL SERIES AND % OF ASSOCIATION		SOIL TEXTURE		DRAINAGE OR PERMEABILITY
						SURFACE LAYER	SUBSURFACE LAYER	
Enon-Mecklenburg 49	Well-drained, brownish, loamy soils that have a yellowian or reddish clayey subsoil; on uplands	Broad ridgetops, long side slopes, and long narrow drainageways	Half in cultivation or pasture--suited to tobacco, small grain, soybeans, lespedeza, and pasture; other half in forests and non-farm uses	Enon	45	Dark-brown to light-olive-brown fine sandy loam or clay loam	Strong-brown to light-olive-brown clay	Well-drained
				Mecklenburg	20	Yellowish-red to dark-brown sandy loam	Red and yellowish-red clay	Well-drained
				Minor Soils	35			
Cecil-Madison 29	Well-drained, brownish, loamy soils that have a reddish clayey subsoil; on uplands	Broad, smooth ridgetops, long side slopes and long narroe drainageways	Half in cultivation or pasture--well-suited to small grain, corn, soybeans, lespedeza, tobacco, and pasture; other half in forests and non-farm uses	Cecil	60	Reddish-brown to dark-brown sandy loam or clay loam	Red clay to clay loam	Well-drained
				Madison	30	Dark-brown to reddish-brown sandy clay loam	Red micaceous clay and clay loam	Well-drained
				Minor Soils	10			
Appling-Vance-Helena 10	Well-drained and moderately well-drained, brownish loamy soils that have a yellowish clayey subsoil; on uplands	Broad ridgetops and and long side slopes	About 75% in cultivation or pasture--well-suited to tobacco, small grain, soybeans, lespedeza, and pasture	Appling	55	Dark-brown to yellowish-brown sandy loam	Yellowish-red to strong-brown clay to sandy clay	Well-drained
				Vance	25	Brown and yellowish-brown sandy loam	Yellowish-red to yellowish-brown clay	Well-drained
				Helena	10	Pale-brown to grayish-brown sandy loam	Strong brown to brownish-yellow sandy clay to clay w/gray mottles	Moderately well-drained
				Minor Soils	10			
Wilkes-Enon 4	Well-drained, brownish, loamy soils that have a yellowish clayey subsoil; on uplands	Narrow, winding ridgetops, long steep side slopes, and long narrow drainageways	Mostly in forests; rest in cultivation or pasture; less sloping areas fairly well-suited to small grain, pasture, and tobacco	Wilkes	60	Grayish-brown to pale-brown sandy loam	Strong-brown to olive clay to sandy loam (upper part clay, middle & lower parts clay loam to sandy loam	Well-drained
				Enon	35	Dark-brown to light olive-brown fine sandy loam or clay loam	Strong-brown to light olive-brown clay	Well-drained
				Minor Soils	5			
Madison-Cecil 3	Well-drained, reddish and brownish loamy soils that have a reddish clayey subsoil; on uplands	Narrow ridgetops, long side slopes, and long narrow drainageways	Mostly in forests or non-farm uses; rest in cultivation or pasture; suited to small grain, corn, soybeans, lespedeza, tobacco, and pasture	Madison	65	Reddish-brown to dark-brown sandy clay loam	Red clay to clay loam	Well-drained
				Cecil	30	Reddish-brown to dark-brown sandy loam or clay loam	Red clay to clay loam	Well-drained
				Minor Soils	5			
Chewacla-Wehadkee-Congaree 3	Somewhat poorly drained and poorly drained, grayish and brownish loamy soils that have a dominantly grayish subsoil, and well-drained, brownish, loamy soils that have a yellowish loamy subsoil on floodplains subject to overflow	Floodplains	Mostly cultivated or/pastures Suited to water-tolerant crops and pasture	Chewacla	60	Dark-brown and light-brown sandy loam	Yellowish-brown to gray clay loam, loam, silt loam, and sandy clay loam	Somewhat poorly drained
			Suited to pasture and water-tolerant trees	Wedhadkee	30	Gray, grayish-brown, brown and dark grayish-brown silt loam and fine sandy loam	Gray silt loam, silty clay loam, sandy clay loam, and loam	Poorly-drained
			Well-suited to most crops	Congaree	10	Brown and dark-brown loam and fine sandy loam	Brownish loamy sand to clay loam with brownish-gray below 28 inches	Well-drained
Coronaca-Mecklenburg 2	Well-drained, reddish and brownish loamy soils that have a reddish clayey subsoil; on uplands	Broad ridgetops and long side slopes	Most in cultivation or pasture--suited to small grain, corn, soybeans, lespedeza, tobacco, and pasture; rest in forest or non-farm uses	Coronaca	55	Dark-red and dark reddish-brown clay loam	Dark red clay	Well-drained
				Mecklenburg	35	Yellowish-red to dark brown sandy clay loam	Red and yellowish-red clay	Well-drained
				Minor Soils	10			

suitabilities of the associations. More detailed information about the series comprised by the associations, including quantitative engineering properties, are presented in the Technical Reference Document (RA-R-406).

Soil Suitability Maps

Figures II-4 and II-5 show the soil suitability for two uses of greatest concern for the proposed project--septic tanks and land application of sewage effluent. The ratings used for the units shown on the map are generally as follows:

Good - indicates that the area is well-suited for the use; few areas are unsuited, and most of the limitations are easily overcome by engineering measures.

Fair - indicates that some parts of the area are poorly-suited for the use; most limitations can be overcome by engineering modifications but only at considerable expense.

Poor - indicates that much of the area is not suited for the use; where engineering modifications will overcome the limitations, such modifications would be expensive.

Unsuitable - indicates that most of the area is not suitable for the use; engineering modifications may render some sites suitable, but the associated costs are likely to be prohibitive.

The soils of almost all parts of the county are well suited for road and building construction. There may be local

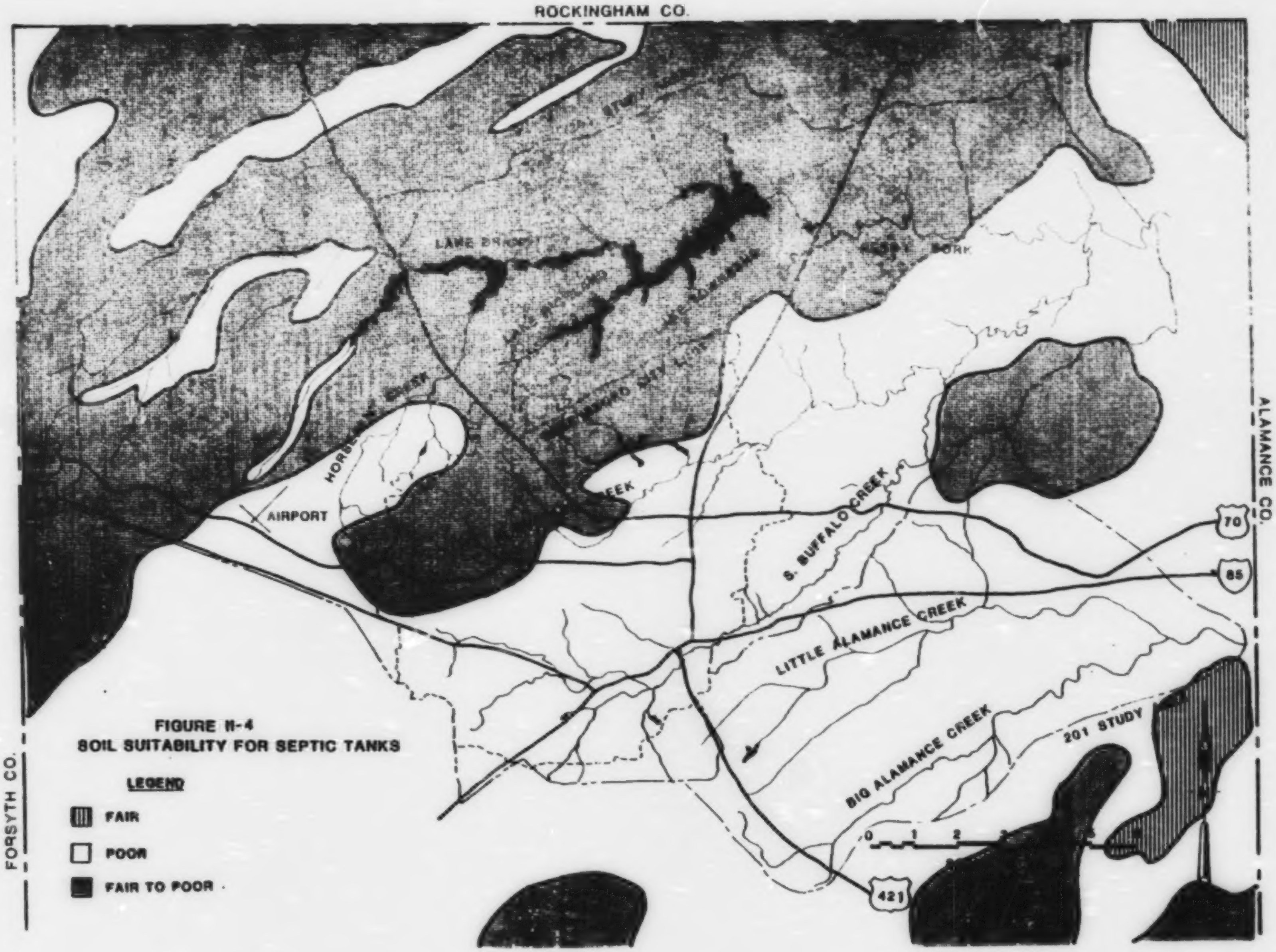

ROCKINGHAM CO.
ALAMANCE CO.
FORSYTH CO.
LAKE BRANDT
LAKE TOWNSEND
GREENSBORO CITY LIMITS
REEDY FORK
HORSEPEN CREEK
AIRPORT
S. BUFFALO CREEK
LITTLE ALAMANCE CREEK
BIG ALAMANCE CREEK
201 STUDY
70
85
421
0
1
2
3
4
LEGEND
▥ FAIR
☐ POOR
■ FAIR TO POOR

FIGURE II-4
SOIL SUITABILITY FOR SEPTIC TANKS

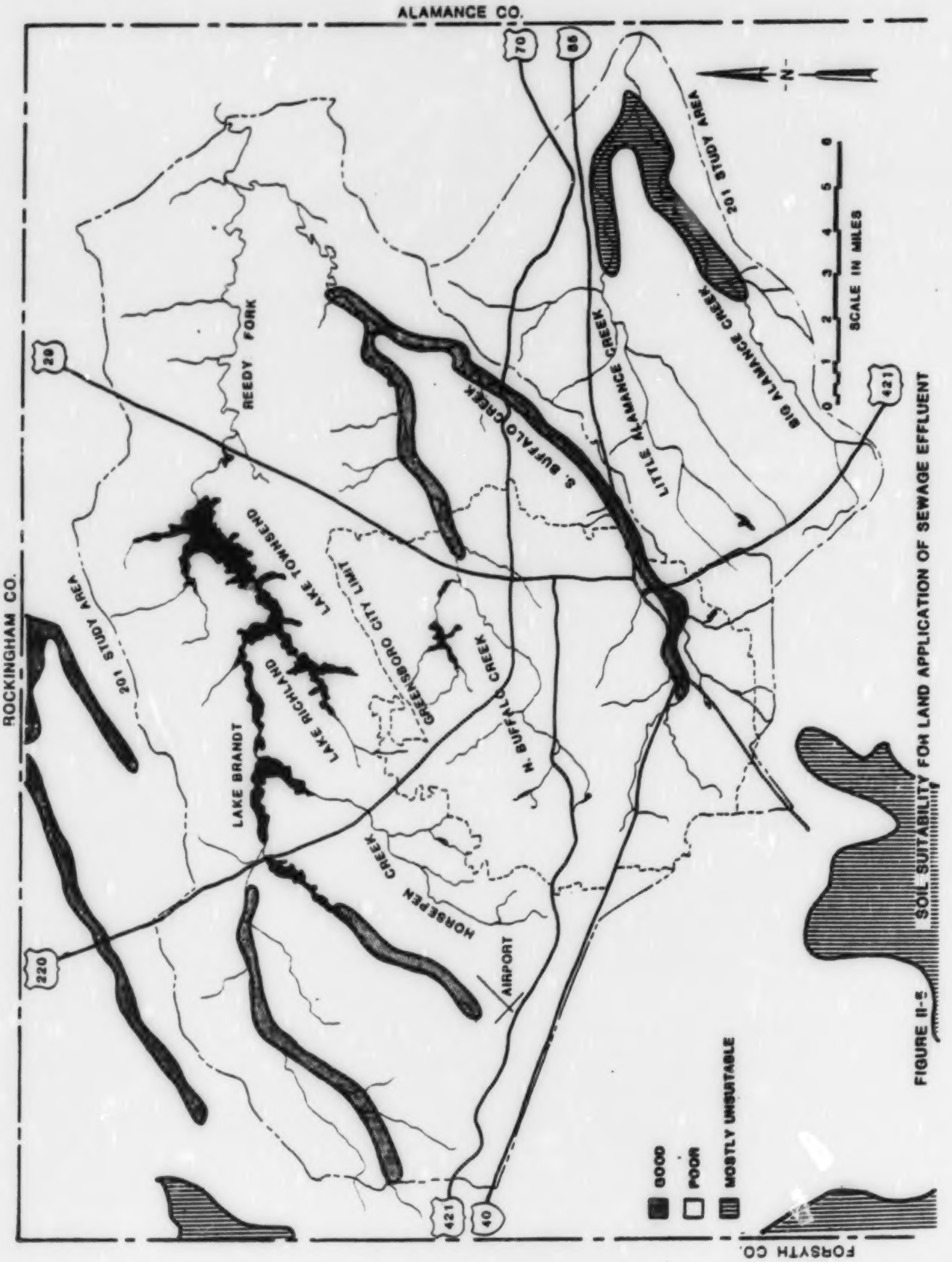

ALAMANCE CO.
ROCKINGHAM CO.
FORSYTH CO.
N
SCALE IN MILES
0
1
2
3
4
5
6
201 STUDY AREA
201 STUDY AREA
70
85
29
220
421
421
40
REEDY FORK
S. BUFFALO CREEK
LITTLE ALAMANCE CREEK
BIG ALAMANCE CREEK
LAKE TOWNSEND
GREENSBORO CITY LIMIT
N. BUFFALO CREEK
LAKE BRANDT
LAKE RICHLAND
HORSEPEN CREEK
AIRPORT
GOOD
POOR
MOSTLY UNSUITABLE

FIGURE II-5 SOIL SUITABILITY FOR LAND APPLICATION OF SEWAGE EFFLUENT

problems of soil consolidation under the load of a structure where saprolite thicknesses are greater than 25 feet, but on-site soil investigations would be required to determine if this problem exists at a proposed building locations.

Certain soils are rated "good" for land application and "poor" for septic tanks; these are the alluvial soils (Chewacla-Wehadkee-Congaree association). The uppermost soil horizons are well-supplied with oxygen and bacteria, and would provide good renovation of the applied effluent soils. Septic tanks and associated drainfields, however, are buried below the upper soil horizon, in material with poor oxygenation and few bacteria. Septic tank effluent is therefore not likely to be renovated when or if it reaches small aquifers associated with the streams. Furthermore, while effluent application usually involves large areas, septic tank effluent flows into much smaller volumes of soil, further limiting the potential for renovation. It should also be noted that the areas having "good" soils for land application are not likely to be used for that purpose in any case for unrelated reasons: their proximity to streams promotes associated surface water quality hazards and periodic operational problems.

It must be emphasized that these maps are highly generalized and are useful only for preliminary planning purposes. The soil associations are composed of soil series having similar but somewhat different properties. Also, the maps indicate suitability of the area only with respect to the soil itself. Little consideration is given to either the processes taking place at the surface or to the bedrock below the soil zone and its properties. For these reasons, a more detailed study would be required at a particular site before its suitability for a specific use can be evaluated. Uniform coverage of the study area with respect to site-specific soil character is not available.

g. Hydrology

(1) Ground-Water Hydrology

The geologic setting of the Greensboro area precludes the existence of major regional aquifers. However, shallow, low-productivity water-table aquifers do exist and serve as important sources of water, particularly in rural areas.

Ground-Water Geology and Aquifer Characteristics

The ground water in Guilford County occurs in two types of material that act as a single aquifer system--the weathered saprolite and underlying fractured bedrock. The water in the saprolite occurs between the grains of weathered materials, whereas the water in the bedrock is in joints, fractures, cleavage planes, and similar openings. Unweathered and unfractured bedrock is essentially nonporous and impermeable, but the fractures in the upper part may provide as much as 1% porosity. Few water-bearing fractures extend below a depth of 300 feet. The upper boundary of the aquifer system is at the water table surface. A diagram illustrating the occurrence of ground water in the saprolite and fractured bedrock is shown in Figure II-6.

In general the saprolite has a much higher porosity (20 to 50%) than the bedrock (mostly less than 1%) (FL-077). However, the saprolite is usually much thinner than the bedrock part of the aquifer system. The permeabilities of the two parts of the aquifer are about the same--from 1 to 100 gal/day/ft^2. Most wells are cased through the saprolite and are left as open holes in the fractured bedrock. When a well is pumped, the water is usually taken from the bedrock, but much of the water enters the bedrock fractures as leakage from the overlying saprolite that has a higher water content (FL-077). In some areas of the county, however, the saprolite is too thin to serve as a significant aquifer or the water table is below the saprolite.

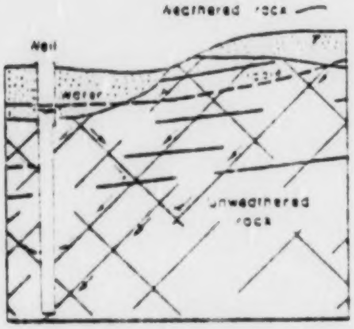


FIGURE II-6

DIAGRAM SHOWING THE OCCURRENCE OF GROUND WATER
IN SAPROLITE AND UNDERLYING FRACTURED BEDROCK

Attempts have been made in the past to determine relationships between aquifer productivity and the bedrock geology portrayed in Figure II-6. However, other factors besides bedrock lithology, such as saprolite thickness and topographic position, appear to have greater effect on aquifer productivity. These factors will be described in more detail in a later section.

Recharge, Movement, and Discharge of Ground Water

Recharge of the aquifers in Guilford County is from precipitation. Most recharge occurs in the uplands, and groundwater movement is from these upland areas toward the stream bottoms. Discharge from the aquifers is primarily by well pumpage, by evapotranspiration from springs, and as baseflow to streams. Very little ground water flows out of the drainage basin into which it infiltrates; the ground water is therefore best viewed as subsurface runoff that reaches the streams of the basin much slower than surface runoff.

It has been estimated that about 10 to 15 percent of the annual precipitation of Guilford County infiltrates into the subsurface to become ground-water recharge (FL-077). This percentage is somewhat lower than might be expected, probably because of the low permeability of the soils and the saprolite in the county. The permeability of the shallow substrate in the Alamance Creek basin is about 0.76 in/hr. In the Haw River basin it is about 1.14 in/hr. and in the Deep River basin, it is about 0.81 in/hr. (DI-218).

The water table of the aquifers in Guilford County has the same general shape as the land surface but in subdued form. As a result, the depth to the water table is generally somewhat greater than average on the hills and less than average in valley bottoms. The level of the water table fluctuates systematically through the course of a year because of changes in recharge rates and because of variations in the rate of discharge by evapotranspiration. In general the water table rises relatively quickly during the months of January through March or April, when plants are dormant and precipitation is high. Water levels decline during the remainder of the year, when water losses by evapotranspiration exceed water gains by recharge.

Well and Aquifer Productivity

Wells that are drilled in the Greensboro area are not uniform in productivity, in part because of differences in well construction methods and in part because of inherent variations in the ability of different parts of the aquifer system to produce water. Most wells produce less than 25 gallons per minute. There are some dug and bored wells, restricted primarily to the soft saprolite of the upper parts of the aquifer. Most wells are now drilled through the saprolite and into the underlying fractured bedrock. These wells are generally cased through the saprolite, and water is withdrawn from the bedrock. However, as noted earlier, even in these wells much of the water probably is derived from the overlying saprolite by downward leakage into the bedrock. Most wells would tap the majority of water-bearing fractures within 150 feet of the ground surface, and virtually no wells will have increased productivity by drilling more than 300 feet deep. It is usually more effective to drill two wells to depths of 150 feet than to drill one well 300 feet deep.

Because the saprolite is more porous and contains more water than the fractured bedrock, areas having a thick cover of saprolite will usually produce more ground water than areas with thin saprolite, provided that the water table is encountered at about the same depth. Wells that are drilled in valleys or other topographic depressions will generally produce more water than wells on ridges or hilltops. There are two reasons for the greater productivity in low areas. (1) most ground-water flow is from upland areas toward the streams, so the greatest flow and water availability is in the low areas; and (2) the low areas have formed as depressions because the bedrock is often intensely fractured, and less resistant to erosion. This in turn promotes high ground-water content (LE-266).

Differing estimates have been made for the total quantity of ground water that might be available in the Guilford County area. In one study, empirical relationships were established between precipitation rates and rates of ground-water recharge for the major drainage basins in the county. Under the assumption that the maximum safe rate of ground-water withdrawal is about equal to the rate of recharge, it was estimated that about 33 million gallons per day (MGD) of ground water may be available (DI-128). This estimate is probably conservative.

Using another method that is based on streamflow data, the North Carolina Department of Natural and Economic Resources has more recently estimated that as much as 145 MGD might be available from ground-water sources (NA-337). The U.S. Geological Survey has estimated the availability at about 160 to 195 MGD (NA-337).

Ground-Water Use

Because of the relatively low productivity of most wells in the Greensboro area, ground water is used primarily by single-residence domestic wells. However, several industries and the town of Gibsonville also utilize ground water as a water source (NA-337). As early as 1948 about 375 wells had been catalogued in Guilford County (MU-130). The total use of ground water in the county has been estimated at 11 MGD (DI-128).

Ground-Water Quality

The natural ground-water quality in the Greensboro area is quite good. Probably the most troublesome water quality problem is an objectionably high iron content in some areas. A more serious ground-water problem in the Greensboro area is that of aquifer pollution from man-made sources. The most serious and widespread threat to ground-water quality is from numerous septic tanks in the area, although other sources of contamination are also present. Where septic tank density is not too great, the thick soils and saprolite in most areas should serve to renovate the septic tank effluent quite well before it reaches any aquifer systems. In many areas, however, low permeability or insufficient soil thickness limits the number of septic tanks that can be accommodated satisfactorily. It appears that the safe number of septic tanks has already been exceeded in some places, owing primarily to poor siting and/or maintenance. Most of the county is considered to have about the same potential for site-specific problems and ground-water quality degradation from septic tanks.

(2) Surface-Water Hydrology

The immediate Greensboro area is drained by several major tributaries to the Haw River. These flow in a generally northeast direction and tend to parallel each other. The area to the southwest of Greensboro is drained by the East and West Forks of the Deep River, both of which drain generally southeastward. Figure II-7 shows the main creeks draining the Greensboro and surrounding areas. The creeks eventually draining into the Haw River include (from north to south):

- Reedy Fork
- Horsepen Creek
- North Buffalo Creek
- South Buffalo Creek
- Little Alamance Creek, and
- Big Alamance Creek

Main tributaries to the Deep River include (from west to east):

- West Fork, Deep River
- East Fork, Deep River
- Hickory Creek, and
- Polecat Creek

Of these creek basins only two, North and South Buffalo, have significant areas of extensive urbanization. Watersheds with limited but increasing acreage under development include Horsepen Creek, Little Alamance Creek, and the East Fork of the Deep River. The remaining basins are primarily natural and agricultural watersheds having little development as yet.

A summary of average stream discharges and 7-day, once-in-10-year low flows (as estimated by the U.S.G.S.) is presented in Table II-6 for the creeks in the Greensboro area. Corresponding data collection sites are shown in Figure II-7. These data

FIGURE II-7

HYDROGRAPHIC AND HYDROLOGIC CHARACTERISTICS OF DRAINAGE BASINS AND SELECTED SITES

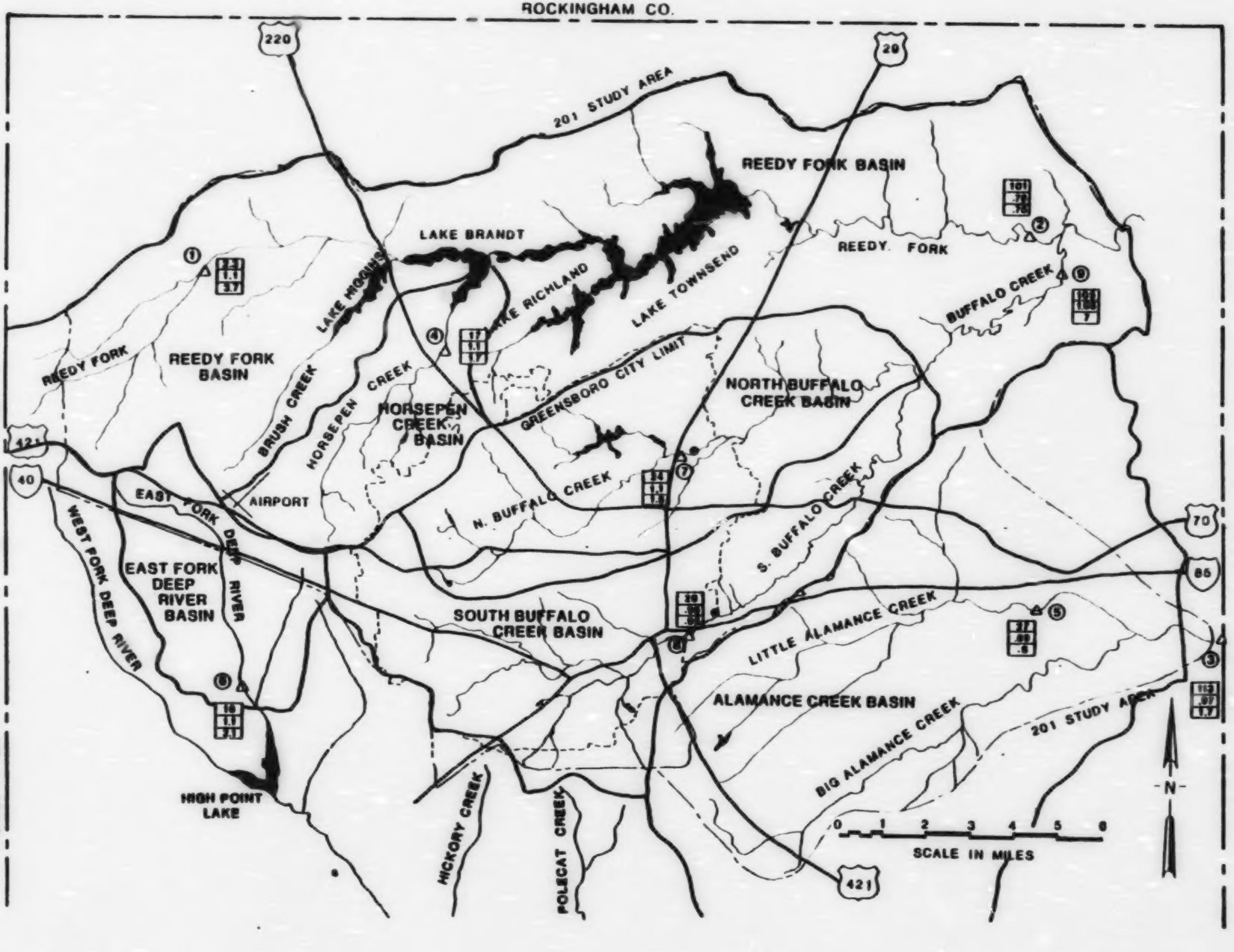

ROCKINGHAM CO.
FORSYTH CO.
201 STUDY AREA
220
29
70
85
40
421
REEDY FORK BASIN
REEDY FORK
BUFFALO CREEK
LAKE BRANDT
LAKE HIGGINS
LAKE RICHLAND
LAKE TOWNSEND
GREENSBORO CITY LIMIT
NORTH BUFFALO CREEK BASIN
N. BUFFALO CREEK
S. BUFFALO CREEK
HORSEPEN CREEK BASIN
HORSEPEN CREEK
BRUSH CREEK
AIRPORT
EAST FORK DEEP RIVER
EAST FORK DEEP RIVER BASIN
WEST FORK DEEP RIVER
HIGH POINT LAKE
SOUTH BUFFALO CREEK BASIN
LITTLE ALAMANCE CREEK
ALAMANCE CREEK BASIN
BIG ALAMANCE CREEK
HICKORY CREEK
POLECAT CREEK
①
②
③
④
⑤
⑥
⑦
⑧
⑨
101
3.7
17
16
20
.6
.97
1.7
0 1 2 3 4 5 6
SCALE IN MILES
-N-
LEGEND
● SEWAGE TREATMENT PLANT
△ STREAM DATA COLLECTION POINT
① SITE NUMBER
AVERAGE FLOW (CFS)
AVERAGE UNIT FLOW (CFS/SQ.MI.)
7 DAY ONCE IN 10 YEAR LOW FLOW (CFS)

TABLE II-6

DRAINAGE AREAS, AVERAGE DISCHARGE, AND 7-DAY-ONCE-IN-10-YEAR LOW FLOW DETERMINATIONS FOR SELECTED STREAM SITES NEAR GREENSBORO, NORTH CAROLINA

	Drainage Area (sq. mi.*)	Average Discharge (cfs**)	7-Day-Once-In 10-Year Low Flow (cfs)	Unit Values (per square mile)	
				Average Discharge (cfs/sq. mi.)	7-Day-Once-In 10-Year Low Flow cfs/sq. mi.
NATURAL WATERSHEDS					
1. Upper Reedy Fork (above lakes)	19.9	22.7	3.7	1.13	.186
2. Reedy Fork (below lakes)	133	101	13.0	.76	.098
2a. Reedy Fork (below Buffalo Creek)	254	280	15.0	1.10	.059
3. Big Alamance (below Little Alamance)	116	113	1.7	.97	.015
DEVELOPING WATERSHEDS					
4. Horsepen	15.9	17.3	1.7	1.09	.017
5. Little Alamance	30.5	27.0	.5	.89	.016
6. East Fork, Deep River	14.7	15.8	2.1	1.07	.146
URBAN WATERSHEDS					
7. North Buffalo (above S.T.P.)†	21.7	24.0	1.50	1.11	.069
8. South Buffalo	29.6	28.0	.95	.95	.032
9. Buffalo	100.0	105.0	7.00	1.05	.070

* Square Mile

** Cubic feet per second

† Sewage Treatment Plant

SOURCE: NO-111

show that runoff per square mile tends to decrease from northwest to southeast, while increases in average flows for urbanized basins appear to be minor (except where influenced by flows from sewage treatment facilities). Unit values for the 7-day, once-in-10-year low flow also tend to show a rapid decline from northwest to southeast. A smaller unit discharge rate occurs on lower Reedy Fork due to the lake system upstream.

Reedy Fork Basin

The Reedy Fork watershed drains most of north-central Guilford County. The headwaters are 15 miles northwest of Greensboro and just inside the Forsyth County boundary (see Figure II-6).

Main tributaries to the Reedy Fork are the Brush, Horsepen and Buffalo Creeks. Stream slopes range from about 16 feet per mile in the upper reaches to less than 4 feet per mile in the lower reaches. The channel cross section is typically steep-sided, and flooding is limited mostly to the stream channel itself.

Two on-stream impoundments, Lake Brandt and Lake Townsend, provide water to the City of Greensboro. Two additional reservoirs, Lake Richland and Lake Higgins, are located on tributaries to Reedy Fork. Lake Richland supplies water to Cone Mills, a textile plant. The effect of these lakes is to reduce flood flows and stabilize low-flow conditions. The cumulative influence of these conditions is seen in Table II-6, as a reduction in average discharge per square mile drained by Reedy Fork below the lakes, as compared to other creeks in the area.

Urban development in the Reedy Fork Basin is presently limited to scattered, primarily residential areas. Most of this development is to the north of Greensboro and south of the lakes.

If past growth patterns continue, this area will become increasingly urbanized, and the percentage of runoff reaching Lakes Richland and Townsend will also be increased, although the amount of addition is unknown.

Horsepen Creek

The Horsepen Creek watershed is located just northwest and mostly outside the city limits of Greensboro (see Figure II-7). The average width of the basin is about 3 miles, and the length of the main channel is more than 7 miles. The average channel slope is 15.5 feet per mile with much steeper slopes than this in the headwaters and tributaries.

Except for isolated sections, the floodplain is relatively narrow and contains little development. Much of the floodplain in the lower section of the creek is marsh land that serves as a natural deterrent to development. Sections of the floodplain in the upper basin have protective restrictions limiting future growth along the creek. With the exception of Guilford College, most of the area consists of moderate- to low-density residential developments. An isolated tract southeast of the regional airport contains the only well-developed industrialized area.

North Buffalo Creek

The watershed of North Buffalo Creek drains both central and northern sections of metropolitan Greensboro. Its drainage area increases from approximately 23 square miles at the North Buffalo sewage treatment plant, which is located near the eastern city limits, to about 44 square miles where the creek joins South Buffalo Creek. The average basin width is about 4 miles and the length is nearly 12 miles. Stream slopes of North Buffalo Creek range from 45 feet per mile in the upper reaches to about 5.3 feet per mile in the lower section.

North Buffalo Creek has more extensive and intensive urbanization than any other basin in Guilford County. The present extent of this development includes the western two-thirds of the basin. The remaining one-third includes moderate to low population densities comprising primarily residential developments. Although the average flow - drainage basin relationships in North Buffalo Creek above the sewage treatment plant are in line with surrounding natural basins (approximately 1.1 cfs per square mile), peak flow rates have increased significantly with development. Comparisons of unit hydrographs from the early 1930's with those from the early 1970's show an apparent 25 percent increase in peak flow rates. During this period the impervious cover increased from about 4 square miles to more than 11 square miles.

The average streamflow rate at the North Buffalo sewage treatment plant has been determined by the U.S.G.S. to be about 24 cubic feet per second (cfs). Flow at this point is augmented by an average discharge of 10.08 million gallons per day (MGD) or 15.6 cfs from the treatment plant. Another major flow contribution comes from an upstream textile plant (Cone Mills), which discharges an average of 3.5 MGD (5.4 cfs) into the creek.

South Buffalo Creek

South Buffalo Creek has its headwaters about 5 miles southwest of Greensboro and flows in a northeasterly direction. The creek drains much of southern Metropolitan Greensboro. The maximum basin width is 5.5 miles near mid-basin and the width decreases dramatically downstream. The basin has a length of 15 miles and a total drainage area of 45 square miles. Average stream slope for the basin is about 9.6 feet per mile.

Although the floodplain of South Buffalo Creek is somewhat wider than other creeks in the area, channelization has decreased storm runoff water heights. Portions of an industrial area just south of Greensboro appear to infringe upon the floodplain boundaries. Continued development within the floodplain could increase future flood heights.

Existing urban areas are primarily residential with isolated tracts of concentrated industrial development. High-density urbanization occurs within the north central areas of the basin, whereas the remaining basin sections contain mostly moderate- to low-density developments.

Average streamflow at the South Buffalo sewage treatment plant has been determined by the U.S.G.S. to be about 28 cfs. Ninety percent of the time flow exceeds 3 cfs. Flow is augmented at this point by an average daily discharge of 9.58 MGD (14.8 cfs) from the South Buffalo Creek sewage treatment plant.

Alamance Creek

The Alamance Creek watershed as discussed here refers to both the Little Alamance and the Big Alamance Creek basins. These basins are located to the southwest of Greensboro and drain about 113 square miles at their confluence. The average watershed width is about 8 miles and the length is over 13 miles. Stream slopes range from more than 16 feet per mile in the upper reaches to about 10 feet per mile near the confluence. Slopes are somewhat steeper on the Little Alamance Creek branch. Floodplains are very narrow and contain little if any development.

The extent of urbanization is presently limited to northwest sections of the watershed. These are mostly low-density residential tracts and appear to have little effect on stream flows.

East Fork Deep River

The East Fork of the Deep River is located outside and west of the city limits of Greensboro. It drains approximately 19 square miles where it enters High Point Lake, one of the water supply reservoirs for the town of High Point. The basin has an average width of about 3 miles and is 6.5 miles in length where it drains into the lake. The average stream slope is a steep 20 feet per mile. The stream channel is relatively narrow and therefore limits flooding in most areas to the vicinity of the stream channel.

Present urbanization is concentrated near the north watershed boundary. Most of this urbanization is industrial development with limited sections of residential buildings. The east and south sections of the basin contain isolated sections of low-density residential developments.

Above High Point Lake the average flow determined by the U.S.G.S. is 15.8 cfs, and 90 percent of the time the flow exceeds 4 cfs. The 7-day, once-in-10-year low flow is about 2 cfs.

Reservoirs

The major reservoirs in the area lie in the Reedy Fork Creek drainage basin and serve as the raw water supply for the City of Greensboro. The reservoir system consists of a series of four lakes - Lake Higgins, Lake Brandt, Lake Richland and Lake Townsend. Lake Higgins is on Brush Creek, a tributary to Reedy Fork. The lake has a drainage area of 12 square miles and a storage capacity of 107 million cubic feet. Lake Brandt receives streamflow from West Reedy Fork and Horsepen Creeks and is supplemented by water released from Lake Higgins. The drainage area of Lake Brandt is 70 square miles. Storage capacity is approximately 294 million cubic feet. Lake Townsend, which has a storage capacity of 869 million cubic feet, is the largest reservoir in the area. The reservoir is located on Reedy Fork and has a drainage area of 105 square miles. Water is pumped from Lake Richland into Buffalo Lake, a small lake in the City of Greensboro. Water from Buffalo Lake is used by the Cone Mills textile plant for process water.

(b) Surface Water Quality

Information reviewed for assessing existing water quality conditions of the area streams and lakes in the EIS study area included data from the City of Greensboro, and the North Carolina Division of Environmental Management Monitoring Survey. Combining and correlating data from these sources provides a basis for describing present water quality conditions in the study area and identifying problem sources which affect surface water quality.

Wastewater Discharge

The major wastewater discharges in the study area include the North Buffalo Creek wastewater treatment plant, with an average flow of 10.08 MGD, the South Buffalo Creek wastewater treatment plant, with an average flow of 9.58 MGD, and the Cone Mills textile plant, with a treated-dye waste discharge of 3.5 MGD. Other minor wastewater discharges include the Reedy Fork Creek sewage treatment plant (0.05 MGD), Troxler Hosiery (0.003 MGD), Cone Mills (Olympic Products) (0.005 MGD), American Oil Company (0.001 MGD), Morgan Poultry (0.15 MGD), and the Kernersville Wastewater Treatment Plant (0.7 MGD). The U.S.S. Agri Chemical Plant also discharges nitrogen-containing waste to South Buffalo Creek, but the volume is unknown.

The geographical locations of these discharges are shown on Figure II-8. Wastewater from the Kernersville plant, Morgan Poultry, and the American Oil Company are discharged into streams that are tributary to Lake Brandt.

Non-Point Waste Sources

Non-point-source pollution occurs as a result of storm water runoff. Some of the major contributors are urban runoff, agricultural runoff, runoff from construction activity, and septic tanks. The type and amount of contaminants in surface runoff will vary largely as a function of land use. In urban areas contaminants accumulate in the streets and on land surfaces between storm events. During storm runoff, the contaminants are carried to the receiving stream and can cause significant degradation of stream water quality. In addition, soil erosion currently contributes more than 150 tons of sediment per square mile to streams in Guilford County (SI-138).

Area Stream Water Quality Classifications

Shown in Figure II-9 are the monitoring sites operated by the NCDEM and the City of Greensboro. Water quality data from these sites were used to assess present conditions of area streams. The State of North Carolina Division of Environmental Management has classified area surface water according to the best intended use of those waters. Stream segments within in the study area are classified as follows in Table II-7.

Class A-II waters are intended for use as water supply for drinking or food processing. The intended use for Class C waters are for fishing, boating, wading and other uses except for bathing and water supply.

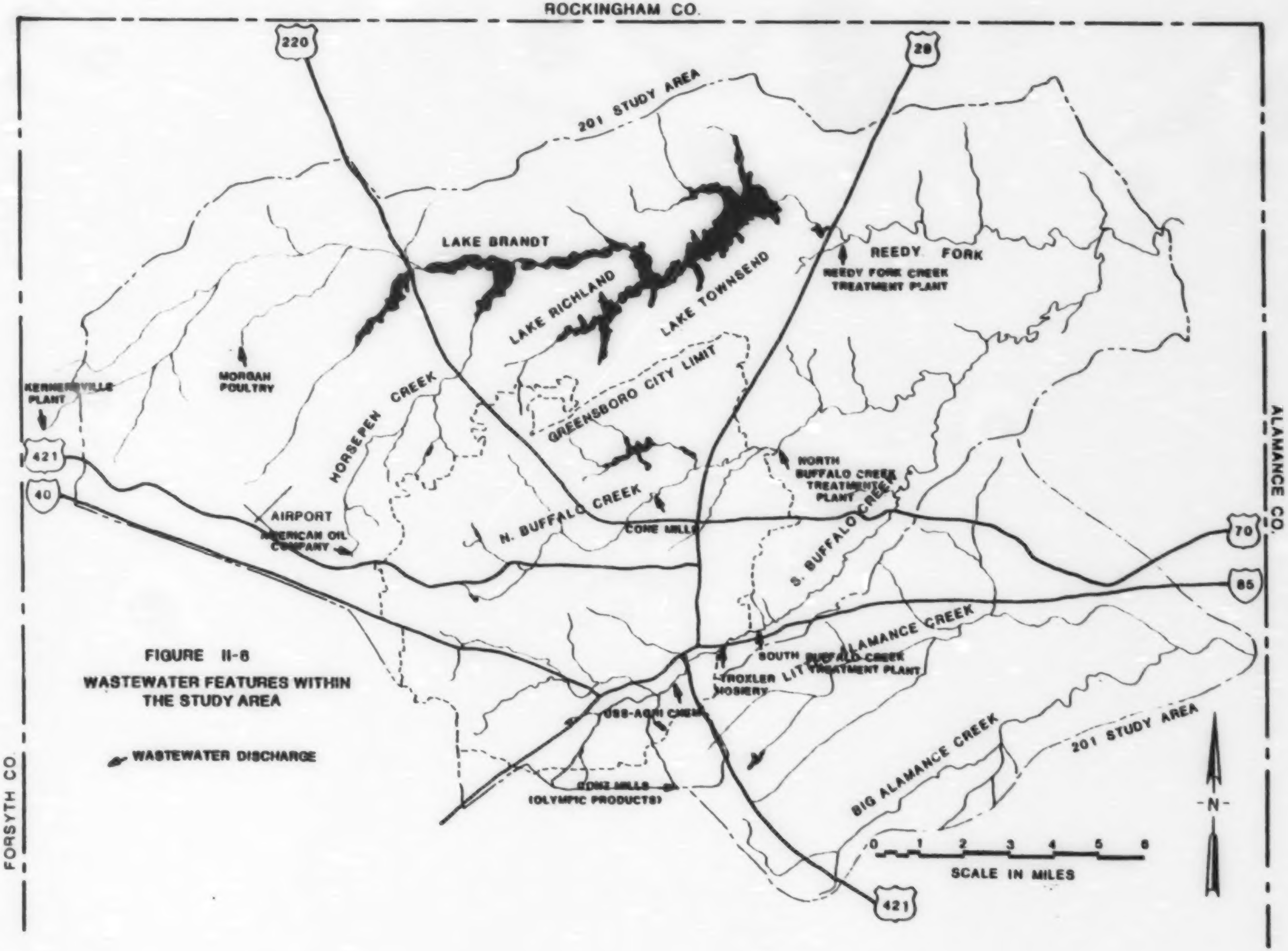

ROCKINGHAM CO.
ALAMANCE CO.
FORSYTH CO
220
29
70
85
421
40
421
201 STUDY AREA
201 STUDY AREA
LAKE BRANDT
LAKE RICHLAND
LAKE TOWNSEND
REEDY FORK
REEDY FORK CREEK TREATMENT PLANT
GREENSBORO CITY LIMIT
KERNERSVILLE PLANT
MORGAN POULTRY
HORSEPEN CREEK
AIRPORT
AMERICAN OIL COMPANY
N. BUFFALO CREEK
CONE MILLS
NORTH BUFFALO CREEK TREATMENT PLANT
S. BUFFALO CREEK
SOUTH BUFFALO CREEK TREATMENT PLANT
LITTLE ALAMANCE CREEK
TROXLER HOSIERY
USS-AGRI CHEM
CONE MILLS (OLYMPIC PRODUCTS)
BIG ALAMANCE CREEK
N
0 1 2 3 4 5 6
SCALE IN MILES
WASTEWATER DISCHARGE

FIGURE II-6

WASTEWATER FEATURES WITHIN THE STUDY AREA

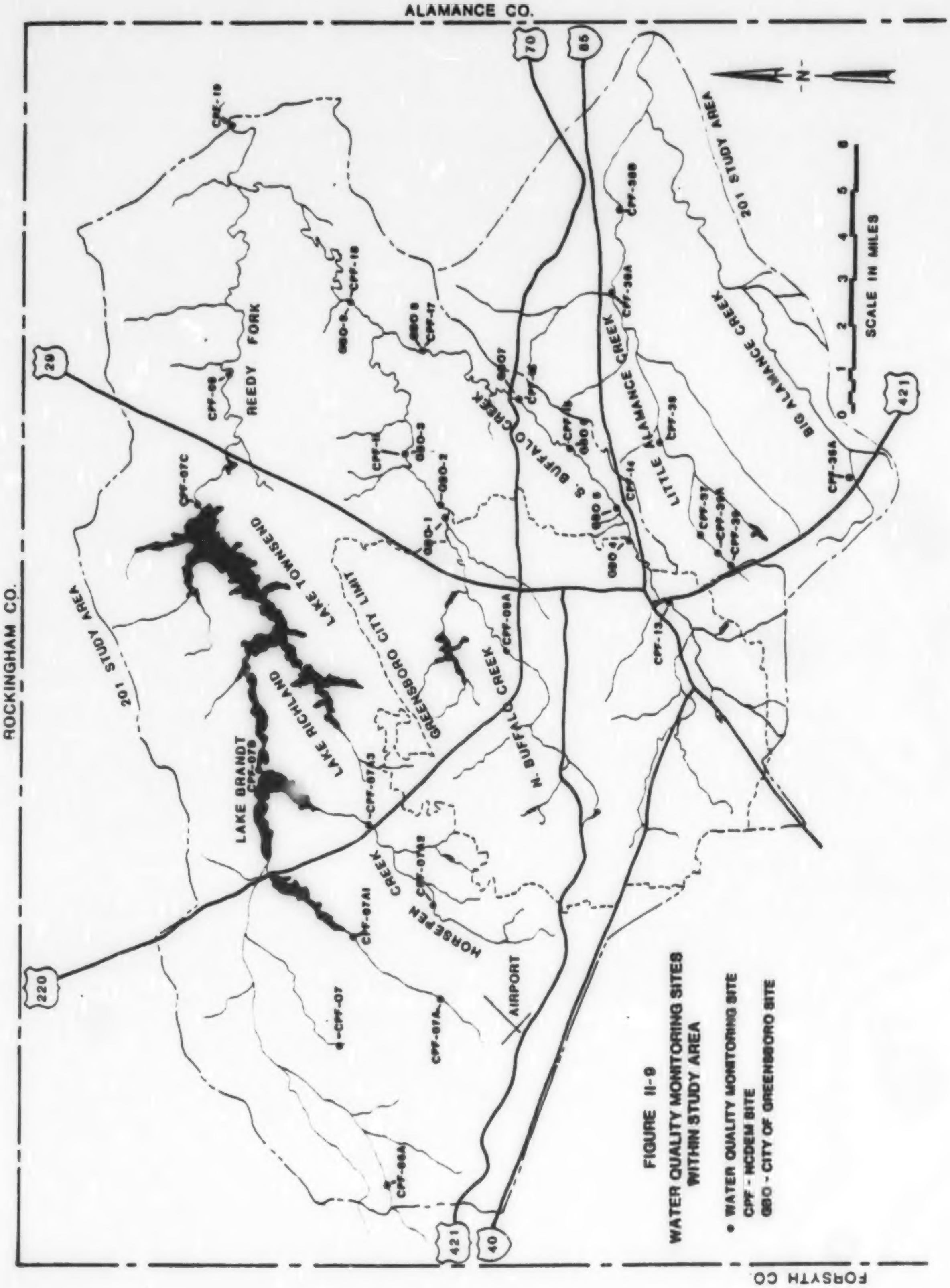

ALAMANCE CO.
ROCKINGHAM CO.
FORSYTH CO.
201 STUDY AREA
201 STUDY AREA
70
85
29
220
421
421
40
N
SCALE IN MILES
0
1
2
3
4
5
6
REEDY FORK
LAKE TOWNSEND
LAKE BRANDT
LAKE RICHLAND
GREENSBORO CITY LIMIT
S. BUFFALO CREEK
N. BUFFALO CREEK
LITTLE ALAMANCE CREEK
BIG ALAMANCE CREEK
HORSEPEN CREEK
AIRPORT
CPF-19
CPF-18
CPF-17
GBO 8
GBO-9
CPF-09
CPF-07C
CPF-16
GBO7
CPF-11
GBO-3
GBO-2
GBO-1
CPF-15
GBO 5
GBO 6
GBO 4
CPF-14
CPF-38B
CPF-38A
CPF-38
CPF-37
CPF-39A
CPF-39
CPF-38A
CPF-13
CPF-09A
CPF-07A3
CPF-07B
CPF-07B3
CPF-07A1
CPF-07
CPF-07A
CPF-06A

FIGURE II-9
WATER QUALITY MONITORING SITES
WITHIN STUDY AREA

• WATER QUALITY MONITORING SITE
CPF - NCDEM SITE
GBO - CITY OF GREENSBORO SITE

TABLE II-8

MONTHLY AVERAGE DISSOLVED OXYGEN IN NORTH AND SOUTH BUFFALO CREEKS

Year	Month	S. Buffalo at McConnell Road	S. Buffalo at Stream Mile 1.2	N. Buffalo at Stream Mile 4.9
1975	September	7.1	1.5	2.9
	October	7.7	3.0	4.0
	November	8.3	4.1	4.6
	December	10.0	5.9	6.4
1976	January	10.8	7.7	7.4
	Feburary	9.9	7.1	6.4
	March	8.8	3.9	5.2
	April	7.9	1.6	2.6
	May	7.2	3.2	3.5
	June	6.4	2.4	4.1
	July	6.9	2.4	2.7
	August	6.6	1.6	3.2

TABLE II-7

STATE OF NORTH CAROLINA WATER QUALITY CLASSIFICATION OF GUILFORD COUNTY STREAMS

Stream Segment	Class
Reedy Fork (west)	A-II
Moores Creek	A-II
Brush Creek	A-II
Horsepen Creek	A-II
South Buffalo Creek	C
North Buffalo Creek	C
Buffalo Creek	C
Reedy Fork (east)	C
Big Alamance Creek	A-II
Little Alamance Creek	A-II
Alamance Creek	A-II

South Buffalo Creek

South Buffalo Creek is probably the most polluted stream in the study area. Dissolved oxygen (D.O.) levels downstream of the South Buffalo Wastewater Treatment Plant are consistently below 5.0 mg/l. Figure II-10 shows the observed range of dissolved oxygen concentrations in South Buffalo Creek from data collected from NCDEM. Table II-8 shows the monthly variation in average D.O. levels at two sites on South Buffalo Creek sampled by the City of Greensboro. The monthly variation at McConnell Road averages above the minimum of 5.0 mg/l, while average monthly D.O. levels at stream mile 1.2 consistently fall below the 5.0 mg/l minimum. Table II-8 shows that South Buffalo Creek was low in D.O. during August of 1976. The range of D.O. concentrations observed in August of 1976 are shown in Figure II-11 for the stream reach sampled by the City of Greensboro. High counts of fecal coliforms were observed at all sampling sites

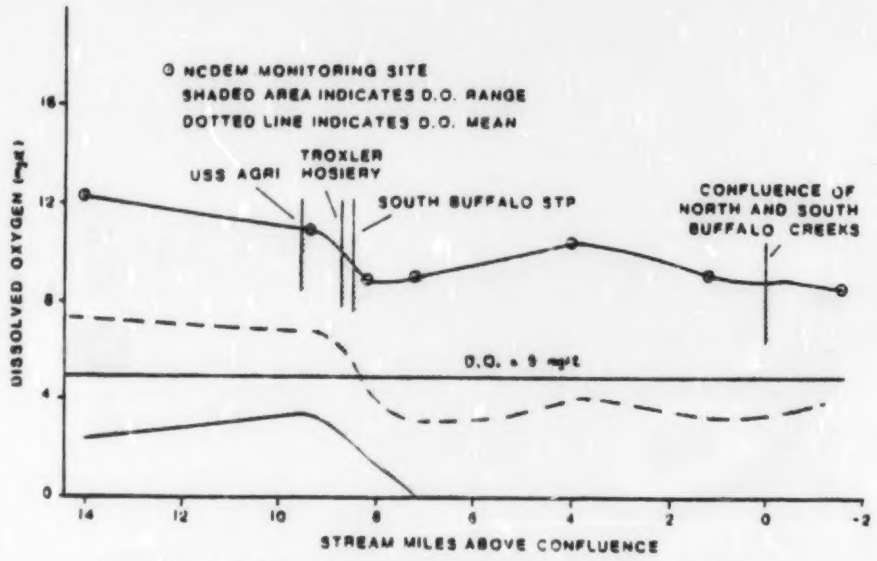


FIGURE II-10 DISSOLVED OXYGEN PROFILE OF SOUTH BUFFALO CREEK (DATA FROM STATE OF NORTH CAROLINA)

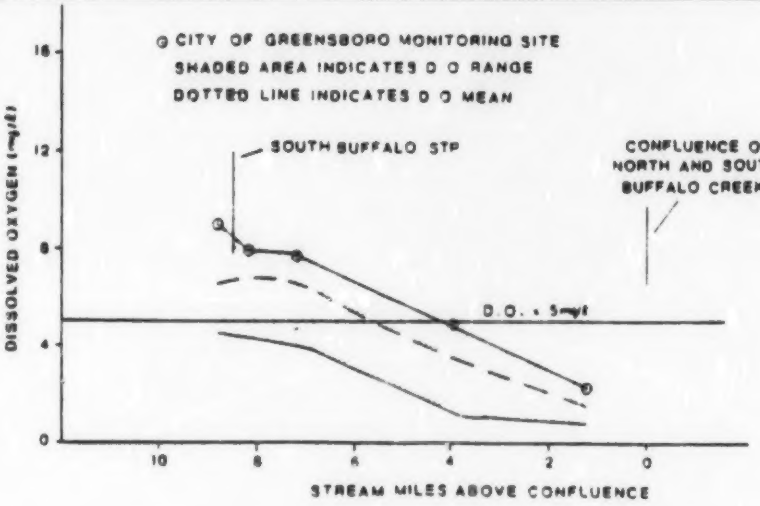


FIGURE II-11 DISSOLVED OXYGEN PROFILE OF SOUTH BUFFALO CREEK FOR AUGUST 1976 (DATA FROM CITY OF GREENSBORO)

operated by the NCDEM. The average count per 100 ml ranged from 24,742 to 54,556 for the six stations sampled by NCDEM on South Buffalo Creek. Values of pH below 6.0 were consistently observed below the discharges from USS Agri Chemical and Agrico Chemical companies. However, the pH value has increased (probably from dilution) to acceptable levels at the NCDEM sampling site at Highway 6 and South Buffalo Creek. Figure II-12 shows the range of B.O.D. concentrations observed in South Buffalo Creek. The figure shows the increased B.O.D. load caused by the South Buffalo Treatment Plant. High concentration of total Kjeldahl nitrogen, ammonia nitrogen and total phosphorus are present in South Buffalo Creek and are probably a combined load exerted by the industrial discharges and the South Buffalo Treatment Plant discharge.

North Buffalo Creek

The dissolved oxygen levels in North Buffalo Creek are below 5.0 mg/l in places downstream from effluent discharges from Cone Mills Corporation and the North Buffalo Wastewater Treatment Plant. Figure II-13 shows the range of dissolved oxygen concentrations observed by the NCDEM from June, 1968 to January, 1975. Table II-8 shows the monthly variation in average D.O. observed by the City of Greensboro in North Buffalo Creek at SR 2832. The D.O. levels in the stream reach sampled by the city during August, 1976 are shown in Figure II-14. These data show that average D.O. levels fall below 5.0 mg/l downstream of the treatment plant. High fecal coliform counts have been observed at NDCEM sampling sites below Cone Mills (average of 51,415/100 ml) and below the North Buffalo Waste Treatment Plant (average of 145,743/100 ml). Value of pH higher than 8.5 are observed at the NCDEM sampling site below Cone Mills, but pH values are in the acceptable range of 6.0 to 8.5 below the North Buffalo Treatment Plant. Figure II-15 shows the range

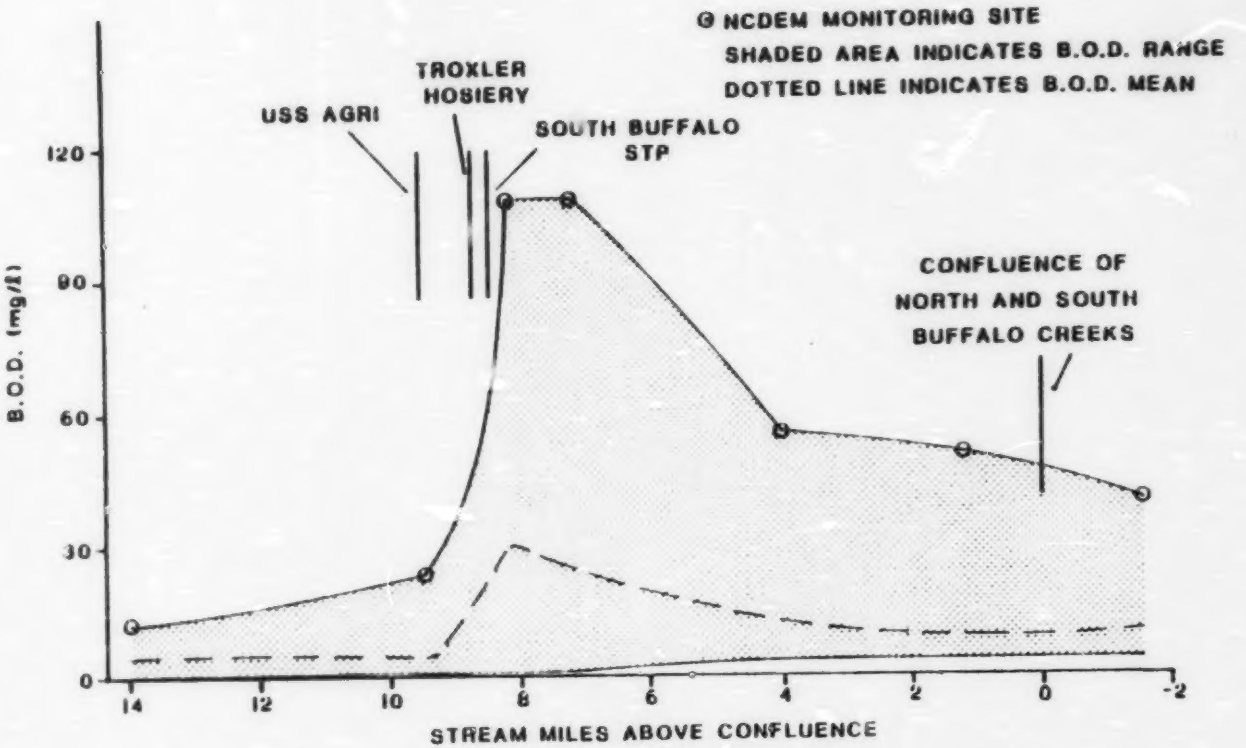


FIGURE II-12 B.O.D. LOAD IN SOUTH BUFFALO CREEK
(DATA FROM STATE OF NORTH CAROLINA)

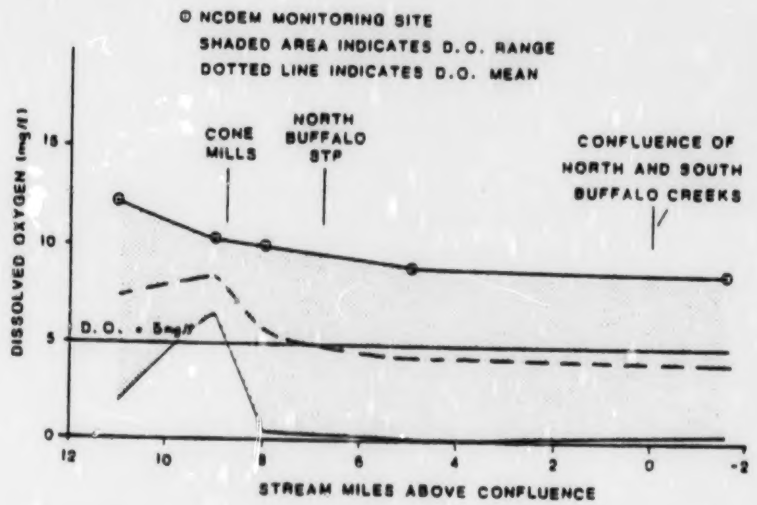


FIGURE II-13 DISSOLVED OXYGEN PROFILE FOR NORTH BUFFALO CREEK (DATA FROM STATE OF NORTH CAROLINA)

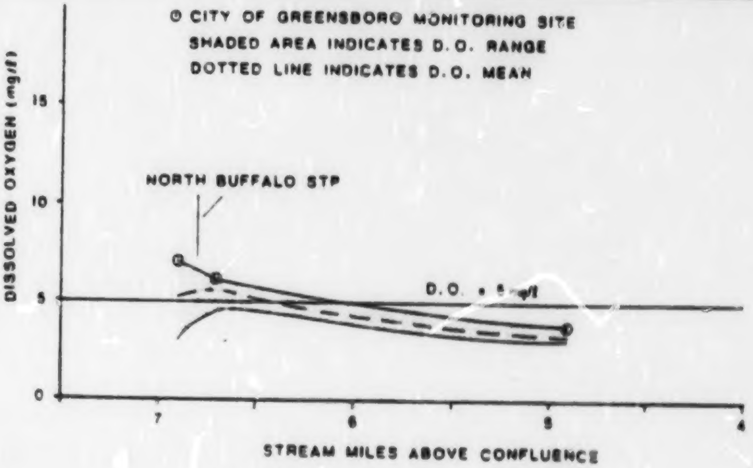


FIGURE II-14 DISSOLVED OXYGEN PROFILE FOR NORTH BUFFALO CREEK FOR AUGUST, 1976 (DATA FROM CITY OF GREENSBORO)

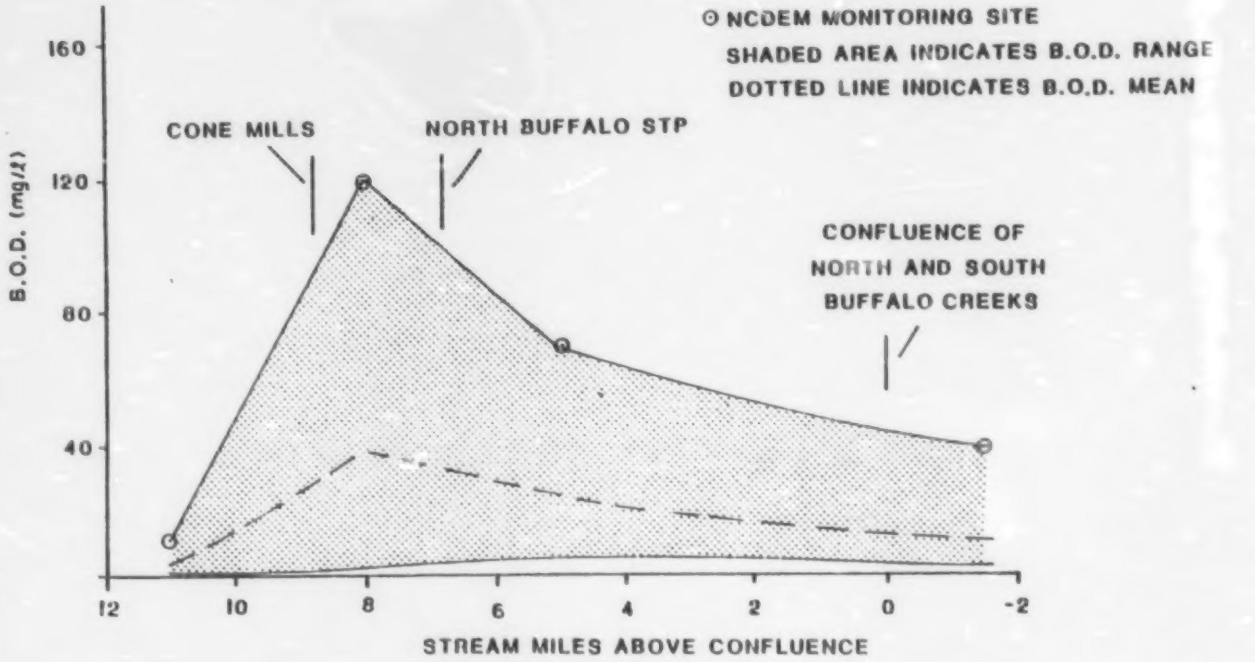


FIGURE II-15 B.O.D. CONCENTRATION IN NORTH BUFFALO CREEK (DATA FROM STATE OF NORTH CAROLINA)

of B.O.D. concentrations observed in North Buffalo Creek from June, 1968 to January, 1975. Figure II-15 shows that the B.O.D. load caused by Cone Mills is high and that it contributes significantly to the degradation of water quality in North Buffalo Creek. The North Buffalo Treatment Plant is the most significant source of total Kjeldahl nitrogen, ammonia nitrogen and total phosphorus.

Reedy Fork

The headwaters of Reedy Fork and its tributaries are classified A-II. This stream system drains into Lake Brandt, a water supply reservoir for the City of Greensboro. The NCDEM operates water quality monitoring stations at three sites upstream of the reservoir: (1) on Reedy Fork below the effluent discharge from Kernersville Water Treatment Plant; (2) on Moores Creek below the discharge from Morgan Poultry; and (3) at two sites on Brush Creek. Water quality data from these monitoring sites show that Reedy Fork and its tributaries above Lake Brandt are of high water quality. No contraventions of stream standards have been observed.

Reedy Fork downstream of Lake Townsend is classified C. NCDEM operates a quality monitoring site (CPF 08) downstream of discharges from Pinnix Mobile Home Park, Wysong and Miles, and Autumn Forest Development. The stream is of good quality; only one observed dissolved oxygen level is below 5.0 mg/l. The stream is monitored at North Carolina Highway 61 (CPF 19), which is below the Reedy Fork confluence with Buffalo Creek. Low D.O. levels and high counts of fecal coliforms have been observed. These are believed to be caused by the discharge from Buffalo Creek.

Alamance Creeks

The NCDEM operates six water quality monitoring sites on Little Alamance Creek. Existing data collected at these sites show the stream to be generally of high water quality. Dissolved oxygen levels below 5.0 mg/l have been recorded at Little Alamance and U.S. 421 (CPF 036), but low D.O. levels have not been observed at the downstream station at SR 3314 (CPF 037). The fecal coliform data at SR 3077 (CPF 038) downstream of Country Club Mobile Home Park show an average of 4798/100 ml. However, this count decays to acceptable levels before downstream monitoring sites are reached.

Water quality data on Big Alamance Creek are not sufficient to assess the quality of the stream. However, it is believed to be of high quality.

Horsepen Creek

The NCDEM operated two water quality monitoring sites on Horsepen Creek from February, 1974 to April, 1975. Analysis of the data shows Horsepen Creek to be of high water quality. Dissolved oxygen levels are high, and B.O.D. levels are low. Malfunctioning septic tanks are known to exist in the Horsepen Creek basin. Data from the NCDEM monitoring site on Horsepen Creek located at SR 2136 indicates that contamination by fecal coliforms presently exists. The average count per 100 ml for seven samples was 2985. However, this value does not contravene stream standards for a Class A-II stream. Data from seven samples taken at the downstream NCDEM monitoring site at Horsepen Creek and U.S. 220 show that the average fecal coliform count had decayed to 260/100 ml.

Reservoir Water Quality

Lake Higgins, Lake Brandt, Lake Richland and Lake Townsend form the reservoir system that provides Greensboro's raw water supply. Due to the limited water supply, protection of this reservoir system is widely perceived as a necessity. Sediment-laden storm runoff is by far the most significant non-point source pollutant.

Tables II-9 and II-10 show average chemical and physical characteristics of raw water withdrawn from Lake Brandt and Lake Townsend, respectively. The only significant difference in water quality of these two sources is the higher concentration of iron (Fe) occurring in Lake Brandt. Physicochemical characteristics of these two lakes (RA-R-406) indicate that temperature stratification occurs during the summer, which produces partial to complete oxygen depletion in bottom water and probably significantly increases nutrient concentrations during the fall overturn event. However, it appears unlikely that these water quality changes are now accompanied by particularly adverse biologic responses, probably due to the small detention time of these impoundments. However, eutrophication is a potential hazard to the quality of the reservoir water.

At the present time, few quality data are known to exist for these lakes.

h. Sensitive Areas

A composite map delineating areas of potential sensitivity to disturbance, based on their physical characteristics or setting, would include most of the land surface in the EIS

TABLE II-9

CHEMICAL AND PHYSICAL CHARACTERISTICS OF RAW WATER SUPPLY FROM LAKE BRANDT

(Express as mg/1)

Year	pH	Hardness	Alkalinity	CO_2	Fe	Mn	Tur	Color
1961-62	7.0	27	24	6	.75	.52		
1962-63	7.2	24	25	5	.89	.32		146
1963-64	7.2	24	26	5	.87	.18	12	51
1964-65	6.9	19	22	5	1.33	.20	20	135
1965-66	6.9	22	22	5	1.54	.31	47	140
1966-67	7.1	30	31	4	.65	.19	14	42
1967-68	7.0	32	26	4	.77	.15	16	71
1968-69	7.0	32	27	5	1.03	.23	30	83
1969-70	6.6	34	26	6	.79	.19	16	74
1970-71	6.8	30	27	7	1.52	.19	23	70
1971-72	6.8	30	27	9	.88	.26	13	97
1972-73	6.9	31	27	6	.72	.22	18	105

Source: GR-280

TABLE II-10

CHEMICAL AND PHYSICAL CHARCTERISTICS OF RAW SUPPLY WATER FROM LAKE TOWNSEND

(Expressed as mg/1)

Year	pH	Hardness	Alkalinity	CO_2	Fe	Mn	Tur	Color
1969-70	6.7	38	31	6	.44	.17	11	39
1970-71	7.0	37	31	5	.30	.25	5	27
1971-72	7.0	30	28	6	.28	.15	8	46
1972-73	7.0	32	29	6	.35	.18	9	38
1973-74	--	--	--	-	.42	.22	-	--
1975-76*	6.6	33	27	4.3	.15	.03	10.5	45

Source: GR-280

study area. Some areas may, however, be considered sensitive for more than one reason, and the degree of sensitivity is also spatially variable. Consequently, the purpose of this section is to highlight those areas that were identified in previous discussions on the basis of their physical character as susceptible to significant adverse effects that are due to activities of man. Areas deemed sensitive on the basis of biological characteristics or considerations are discussed separately in the following major section of this document.

The only soil association that is considered an erosion hazard is the Enon-Mecklenburg association, which is extensively distributed in the study area (see soil map in the Technical Reference Document, RA-R-406). Particular care must be exercised in areas where these soils must be disturbed, as in construction activity, and erosion and sediment control measures may be necessary, particularly in areas of steeper slopes. For similar reasons, all areas with slopes greater than 25 percent (as shown previously in Figure II-3) are also considered very sensitive to disturbance, without regard to soil type, but areas that have both Enon-Mecklenburg soils and such steep slopes are particularly adverse.

Several hydrologic characteristics also may be used to define sensitive areas. While floodplains of all streams are generally quite narrow and flood hazards exist only within a few feet to a few tens of feet of streams, South Buffalo Creek floodplain along the southern perimeter of Greensboro tends to be significantly wider than average, and the higher flooding potential there, especially as urbanization progresses, requires consideration of this area as sensitive to development. Development on floodplains is not only a hazard to the integrity of the development, but may exacerbate flood hazards both upstream and downstream. Any activity that depends on natural or artificial media for the distribution or storage of aqueous material of degraded character, such as septic tanks or lagoons for chemical wastes, is a potential hazard to ground water quality, if located in those areas that recharge the aquifer. Virtually all areas except the larger stream channels or their floodplains are recharge areas for the widespread shallow saprolite-bedrock aquifer system, but locations on the interfluves (i.e., uplands) may be the primary recharge areas. Consequently, these uplands are most sensitive to activities that could degrade ground water. Because the public water supply of Greensboro is the system of reservoirs on Reedy Creek and its tributaries, these lakes and their tributaries hydrologically are also sensitive areas. Activities that may directly or indirectly degrade quality of these lakes or streams require careful assessment as to the degree to which the water quality is sensitive to that activity.

Areally extensive land-water interfaces, such as wetlands, are dynamic features, and are sensitive both physically and ecologically. In this respect, the marsh that exists where Horsepen Creek joins Lake Brandt is also considered to be an environmenally sensitive area.

2. Biological Components

a. Terrestrial Environment

(1) Vegetation Types

Potential Natural Vegetation

As influenced by topography, climate, and soils, a climax hardwood forest developed in Guilford County which was dominated on upland sites by white, red, and black oaks, and with post, blackjack, southern red and scarlet oaks achieving prominence on the drier sites. Floodplains and low-lying, moist sites were dominated by willow oak, swamp red-oak, and shagbark hickory; beech was found in sheltered ravines (00-004).

Today, almost no virgin forest remains of the original climax cover of the North Carolina Piedmont. Clearing of the native forests for lumber began about 1750 (FU-072) and the cutover areas were subsequently cleared for agriculture. Fields were cultivated until erosion and cropping reduced their fertility past the point of economic return and were then abandoned.

The first year following abandonment, old fields are first dominated by crabgrass and horsewood, followed in the second year by a mixture of aster and ragweed. Broomsedge becomes dominant in the third year and persists until invading Virginia and shortleaf pine shade it out. In ten to fifteen years, pines form close, dense stands; in the Greensboro area, Virginia pine is the dominant old-field invader, occurring in nearly pure stands. After about forty years, hardwoods such as sweetgum, dogwood, sourwood, and several oak and hickory species develop into a distinct understory layer. These species can grow as seedlings in the shade of the pines although the pines themselves cannot. The pines begin to die back in seventy to eighty years and are replaced by the hardwoods. Scattered pines may be found even after 200 years, however, as successional relicts (00-004). Because the woodlands of Piedmont North Carolina are now almost entirely second-growth, late-successional forest, they are presently described as a mixed oak-hickory-pine type (KU-117, BR-355), although the original climax is thought to have been exclusively hardwoods. Fire occurring during this seral sequence favors the growth of pines.

Present Vegetation

The present distribution of late-successional hardwoods, mixed pines and hardwoods, pines, and cultivated or recently abandoned fields, based on 1976 aerial infrared photography is mapped in the Technical Reference Document (RA-R-406). As is readily apparent from these maps, agricultural development and urban expansion have left a patchwork mosaic of small woodlands in various stages of succession. Slightly more than half of the total rural land in the study area is forested.

The vegetation of the study area can be divided roughly into five types (see Table II-11) reflecting the combined influences of topography and successional status. These are (1) mixed pine-hardwoods, (2) floodplain hardwood forest, (3) pine forest, (4) old fields, and (5) currently cultivated fields. Characteristic species found in each are presented in Table II-11. A complete discussion of these vegetation types is presented in the Technical Reference Document (RA-R-406).

Sensitive Botanical Areas

Reports (HA-544; CO-582) indicate that sensitive plant species may be found in the study area. Ginseng, a plant nearly extirpated in pioneer days when it was dug and sold for its supposedly medicinal qualities, is a plant of rich woods and, consequently, would be expected to be restricted in Guilford County to floodplain forests and the moist end of the upland hardwoods continuum. The southern rain-orchid (_Habenaria flava_) and Nestronia (_Nestronia umbellula_) are listed as "threatened throughout" their range in North Carolina. The orchid is a moist lowland species and _Nestronia_ occurs in the more moist mixed hardwood stands. None of these species were found in the immediate vicinity of alternative treatment plant sites, but a more thorough investigation is warranted.

Reproduced from
best available copy.

TABLE II-11

REPRESENTATIVE VEGETATION OF THE GREENSBORO, NORTH CAROLINA AREA

Vegetation Type	SAF Type #	Canopy Trees	Understory Trees	Shrubs and Vines	Herbs
Upland Mixed Pine - Hardwoods (Poor sites)	52, 78	White oak Southern red oak Scarlet oak Black oak Post oak Blackjack oak Chestnut oak Yellow poplar Mockernut hickory Blackgum Virginia pine Shortleaf pine	Flowering dogwood Sourwood Red cedar American holly Sassafras Ironwood Small trees of canopy species	Honeysuckle Blackberry Catbrier Poison ivy Wild grape Blueberry Huckleberry Virginia creeper Saplings of canopy species	Bedstraw Solomon's seal Bellwort Violet Goat's rue Trillium Pipsissewa Seedlings of canopy species
Upland Mixed Pine - Hardwoods (Good sites)	87	White oak Black oak Northern red oak Willow oak Yellow poplar Sugar maple Sweet gum American beech Black walnut Southern red oak Green ash Virginia pine Shortleaf pine Basswood	Flowering dogwood Ironwood Sourwood Redbud Witch hazel Pawpaw Hop hornbeam Red maple American holly Red cedar Small trees of canopy species	Same as above	Same as above
Floodplain Forest	93	American elm Green ash Sycamore Black walnut Slippery elm Willow oak Sugarberry River birch Bitternut hickory Sugar maple Sweetgum	Flowering dogwood Red maple Red mulberry American holly Ironwood Hop hornbeam Chokecherry Pawpaw	Red elderberry Coralberry	
Riparian Forest		Sycamore American elm Green ash River birch Black willow Sweetgum Sugarberry	Red mulberry Silver maple Red maple Hop hornbeam Ironwood American holly	Honeysuckle Elderberry Red grape Poison ivy Box elder Blackberry Catbrier Alder	Violet Wild oats Ryegrass Bottlebrush grass (Disturbed sites) Pokeweed Common mugwort Nettle
Pine Forest	77, 79	Virginia pine Shortleaf pine Blackgum Southern red oak Red maple	Red cedar Sweetgum Flowering dogwood Sourwood Hickory spp. Oak spp.	Catbrier Poison ivey Wild grape Blueberry Blackberry Japanese honeysuckle	Broomsedge Goldenrod Dog-fennel Thoroughwort Beggar's ticks Aster
Old Field				Virginia pine Shortleaf pine Sumac Blackberry	Crabgrass Horseweed Aster Broomsedge Goldenrod Thoroughwort Dog-fennel Bush-clover Beggar's ticks Ragweed
Cultivated Field					Corn Tobacco Cotton Feed grains

Similarly, no areas of virgin woodland have been reported for Guilford County in any of the sources available as of this writing. A systematic search of the entire study area has not been undertaken, but observations made by Hendrickson (HE-214) along North and South Buffalo Creeks indicated that no climax woodlands were present. Examination of infrared false-color aerial photography of the county also fails to reveal any distinctive forest stands. Field checks have not been made. Of the three main late-succession forest types referred to above, none appears to be threatened by human land use to a greater extent than others. Consequently, there seems at present to be no reason, on the basis of existing information, to distinguish any areas of special sensitivity with respect to vegetation.

Vegetation of Proposed Treatment Plant Sites and Sewer Routes

After the site(s) for the selected treatment plant and sewer routes have been identified, a field trip to Greensboro will be made to examine each in detail. At that time, a description of each site's vegetation will be prepared for inclusion in the Final EIS.

(2) Fauna

Relationship to Habitat

While the distribution of animal species throughout the study area is related to the amount and distribution of vegetation cover types, the natural habitat units have been so greatly fragmented (cultivated fields, abandoned fields, and woodlots of varying ages tend to be between 100 and 600 acres in size) that much of the fauna cannot be assigned primarily to one habitat type or another. In keeping with the successional character of the vegetation, species of broad tolerances which live easily in the presence of man and species preferring brushy habitats or open fields have increased at the expense of typical forest species. The pattern of clearing and abandonment which, judging from the present distribution of successional stands, has been going on almost continuously since settlement, is likely to have maintained this type of faunal assemblage over many decades. A detailed list of vertebrate species known or expected to occur in the study area, together with an estimate of their relative abundance, seasons of occurrence, tolerance of man, and habitat preferences has been prepared for this analysis (RA-R-406).

The expansion of Greensboro's suburbs has resulted in a diminution of total numbers of species in these areas, but certain species have benefitted from increased edge habitat and the availability of food. Many species of small birds adapt well to suburban habitats and may rely upon bird feeders for up to half of their winter food supply. Gray and fox squirrels and raccoons, along with house mice and Norway rats, are usually abundant in these situations.

Status of Game Animal Populations

The only big game animal found in Guilford County is the white-tailed deer. Hunting for these animals is limited to the county, owing to the sparsity of populations. The major factors which hold down deer numbers are probably illegal hunting and depredation by free-running dogs (BA-492).

Wild turkey were reported from the area around Lake Brandt in the 1950's. They are presently hunted to a limited extent in the better-wooded northern sections of Guilford County. Like deer, however, they are susceptible to illegal shooting and predation by free-roaming dogs and cats.

Small game affords the greater part of the hunting opportunities in Guilford County. Typical "woodlot hunting" is afforded by the eastern cottontail rabbit, gray squirrel, mourning dove, and bobwhite quail. The cottontail, like the bobwhite quail, has benefitted from the habitat fragmentaion which has hurt deep-woods species. Both thrive in hedgerows, weedy fields, and woodland edges. These are the area's most abundant game animals although their populations tend to fluctuate rather widely from year to year; like other rabbits, cottontail populations are cyclic. Bobwhites are strongly affected by weather during the critical brood-rearing season. Cool, wet springs and summers generally mean low fall and winter populations. Dove tend to follow a similar pattern. Natural predators of these species are far outshadowed in importance by free-running dogs and cats (NO-116).

A small area of land, 756 acres in extent, is maintained by cooperation of the North Carolina Wildlife Resources Commission and local landowners for small farm game. This land is located at the extreme eastern edge of the county at the headwaters of the Travis Creek drainage.

Endangered Species

None of the mammals of Guilford County are considered to be endangered either by the State of North Carolina or by the U.S. Fish and Wildlife Service (US-305, NO-120). The peregrine falcon which may rarely be seen in migration is officially classed as endangered by both entities, as is the bald eagle. The latter species is listed by Dawley (DA-227) as a rare permanent resident in the county. This list was published, however, in 1954, and no recent confirmations are available. Bald eagles prefer wooded areas near water and do not tolerate human activity within a mile or two of an active nest; therefore, it is unlikely, if any eagles still remain in Guilford County's fragmented landscape, that they breed there. The red-cockaded woodpecker is also listed by Dawley as a permanent resident, although recent confirmation is not available. The sharp-shinned hawk, a species listed as threatened (CO-582), is reported to nest near Lake Brandt. The State of North Carolina considers the eastern diamondback rattlesnake an endangered species, although it is not on the national list. Although range maps indicate that this species' overall distribution includes Guilford County (CO-391), its presence there has not been confirmed. The North Carolina Wildlife Resources Commission considers the Dyar moth (Acrabasis fettella) rare in the state which is at the edge of its range. This moth is closely associated with shagbark hickory and may reside in the county.

The white-crowned sparrow, though not in danger as a species, is at the edge of its range in North Carolina. The state's only known wintering population is located in the Horsepen Creek drainage. A small number of wintering birds have been observed around farm buildings adjacent to the Greensboro-Winston Salem regional airport. They probably utilize the waste grain to some extent. Owing to its unfavorable location, it is unlikely that residential land development that would interfere with this population will take place in the near future although industrial use of the land is not precluded.

Figure II-16 shows the locations of all areas considered especially important for the area's wildlife. It should be emphasized, in summary, that the most critical aspect of the area's fragmented woodland habitat is not the areal extent of woodlots, but the degree to which they are interconnected by strips of standing timber, thickets, and fencerows. Although not mapped because of their complexity, these linkages make it possible to maintain the present diversity of animal life by permitting the animals to move between many individual woodlots which could not subsist in the habitat afforded by a single forest stand.

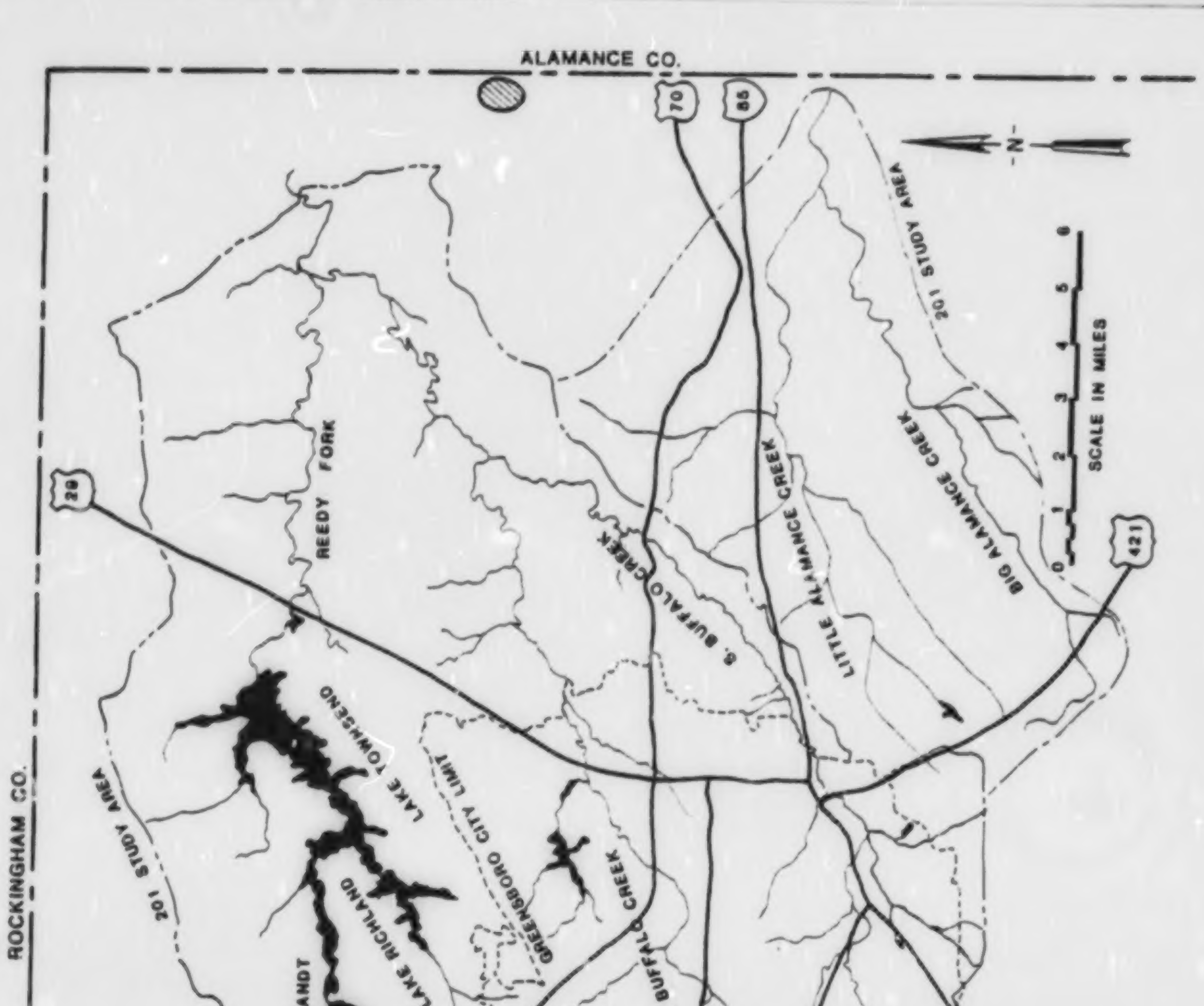

ALAMANCE CO.
ROCKINGHAM CO.
FORSYTH CO.
201 STUDY AREA
201 STUDY AREA
REEDY FORK
LAKE TOWNSEND
LAKE BRANDT
LAKE RICHLAND
GREENSBORO CITY LIMIT
N. BUFFALO CREEK
S. BUFFALO CREEK
LITTLE ALAMANCE CREEK
BIG ALAMANCE CREEK
HORSEPEN CREEK
AIRPORT
29
70
85
220
421
421
40
N
0 1 2 3 4 5 6
SCALE IN MILES

FIGURE II-16
BIOLOGICALLY SENSITIVE AREAS

- ▤ HABITAT OF WHITE-CROWNED SPARROW
- ▥ POPULATIONS OF FRESHWATER CLAMS
- ▨ RELIEF POPULATION OF CRESENT SHINER
- ▒ GUILFORD COUNTY GAME FARM LAND

b. Aquatic Environment

Flowing Streams

Guilford County lies at the headwaters of three small river systems within the Cape Fear drainage, and all of the natural streams in the study area are small. For purposes of this study, only four of these were investigated: Horsepen Creek, Reedy Fork, North and South Buffalo Creeks, and Alamance Creek. These are the county's major drainage basins and will all be affected to some degree by one or more of the alternatives being considered for the Greensboro wastewater treatment system. All drain into the Haw River which flows through the northeastern corner of the county.

All of the four streams discussed here are basically similar with respect to morphology; differences between them arise primarily from the use of both their waters and their watersheds by humans.

Reedy Fork has been repeatedly impounded to supply water to the City of Greensboro; flows in the remaining segments of the creek are therefore artificially regulated by discharge from the lakes. Since both of the city's main sewage treatment plants are located in the Buffalo Creek drainage, water used in Greensboro is effectively transferred from Reedy Fork to the two forks of Buffalo Creek. Sewage effluent now constitutes approximately 55%* or more of the flow immediately below the North Buffalo plant and 45% of the flow below the South Buffalo plant. One apparent consequence of this transfer is to contribute to the continuing instability of the bottom in the two Buffalo Creeks (HE-222). Not only are these streams now carrying a greater volume of water, especially in flood flows, than that which originally formed their channels, but the increment of added flow has not been constant.

---

*Based on streamflow-to-effluent ratio exceeded 50% of the time.

Continuing increase in wastewater effluent reflecting the growth of Greensboro's population and the increase in the extent of runoff-enhancing urbanization have not permitted flow regimes to stabilize. In consequence, the suitability of the bottoms of these two creeks for attached aquatic organisms is generally low.

Very few recent biological data are available for the four streams studied. Most of the descriptions that follow are based on studies conducted by the North Carolina Wildlife Resources Commission in 1973 and 1968 (CA-380, FI-137), and by the Federal Water Pollution Control Administration in 1969 (FE-187). Subsequent improvements in water quality are not reflected in this data base, which should be considered as a worst-case picture of the aquatic ecosystem. Table II-12 summarizes the ecological classification scheme used in the following discussions; this scheme was developed by the North Carolina Wildlife Resources Commission. Figure II-17 shows the locations of all sampling stations from which data or observations have been used in this report.

Horsepen Creek

Horsepen Creek flows through a largely agricultural watershed in which residential development is occurring at an accelerated pace. Throughout the upper portions the banks of the creek are unwooded or bordered only by a narrow fringe of trees; the lower portion, near the mouth of the stream at Lake Brandt, flows through a forested floodplain.

Flow in the creek is not regulated, and typical flows are low (see Table II-8). Although the stream is perennial, low flows are little more than a trickle. Water quality data are not extensive for Horsepen Creek, but observations of the aquatic ecosystem in the stream suggest that pollution is not strongly limiting.

TABLE II-12
CHARACTERISTICS OF ECOLOGICAL CLASSIFICATIONS

TYPE	WIDTH (feet)	DEPTH	MINIMUM FLOW (cfs)	SUMMER TEMP.	TURBIDITY	BOTTOM	FAUNAL TYPES	OTHER
Dace trickle	0-5	Shallow, few pools	0-1	Varies	Clear	Sand, gravel, boulders	Dace, Shiners	Most headwater streams
Robin-warmouth	0-30	Moderately abundant pools	0-30	Warm	Varies	Sand, muck, silt	Robin, other Centrarchids, creek chubs	Typical medium-size Piedmont stream
Largemouth	Over 10	Moderately long deep pools	Over 20	Warm	Varies	Gravel, silt, muck	Largemouth bass, suckers, bullheads	Moderate-size upper Piedmont and some Coastal Plain streams
Largemouth-Pickerel	Over 10	Moderately deep pools	Over 5	Cool	Clear	Predominantly sand	Largemouth bass, chain pickerel, robin	Blackwater upper Coastal Plain streams. Usually highly stained
Catfish-Sucker	Over 10	Moderately deep pools	Over 5	Warm	Varies	Boulders, rubble, silt	Suckers, catfish, various Cyprinids	Moderate-size Piedmont streams
Carp-Catfish	Over 50	Deep	Over 50	Warm	Turbid	Silt, muck, boulders	Carp, catfish	Larger, slow-flowing rivers of Piedmont and Coastal Plain
Smallmouth	Over 10	Moderately abundant pools	Over 5	Cool	Normally clear	Boulders, rubble, gravel	Smallmouth bass, rock bass, crayfish	Moderate-size Foothill streams--generally the reaches immediately below trout water
Sucker	Over 20	Moderate	Over 10	Cool	Varies	Boulders, rubble, silt	Suckers, robin, warmouth, rock bass	Lower reaches of some trout streams
Trout								
(a) Feeder	0-8	Shallow	0-3	70°	Clear	Boulders to sand	Small trout, sculpin, dace	Small headwater tributaries of trout streams
(b) Brook	8-20	Shallow, many pools	3-10	70°	Clear	Boulders to sand	Brook trout, dace	High elevation stream often with barriers to upstream fish migrations
(c) Rainbow	Over 10	Moderate	Over 5	75°	Clear	Boulders to sand	Rainbow trout, dace, chubs	Larger streams generally with heavy, fast-flowing water
(d) Brown	Over 5	Fairly deep large pools	Over 5	75°	Normally clear	Boulders to sand	Brown trout, suckers, chubs, shiners	Lower elevation generally large streams with slow flow, deep pools
Tidal	Over 20	Deep	Over 10	Warm	Varies	Sand, muck, silt	Bass, catfish, white perch, various anadromous species	Coastal streams influenced by wind or lunar tides
Redfin-warmouth	0-30	Few pools or riffles	0-20	Warm	Clear	Sand, muck, silt	Redfin pickerel, warmouth, flier	Swamp drainage streams of Coastal Plain
Dredged	0-30	Shallow, no pools	0-100	Warm	Varies	Sand, silt	Shiners, small Centrarchids	Coastal Plain and some Piedmont streams

Source: FI-137

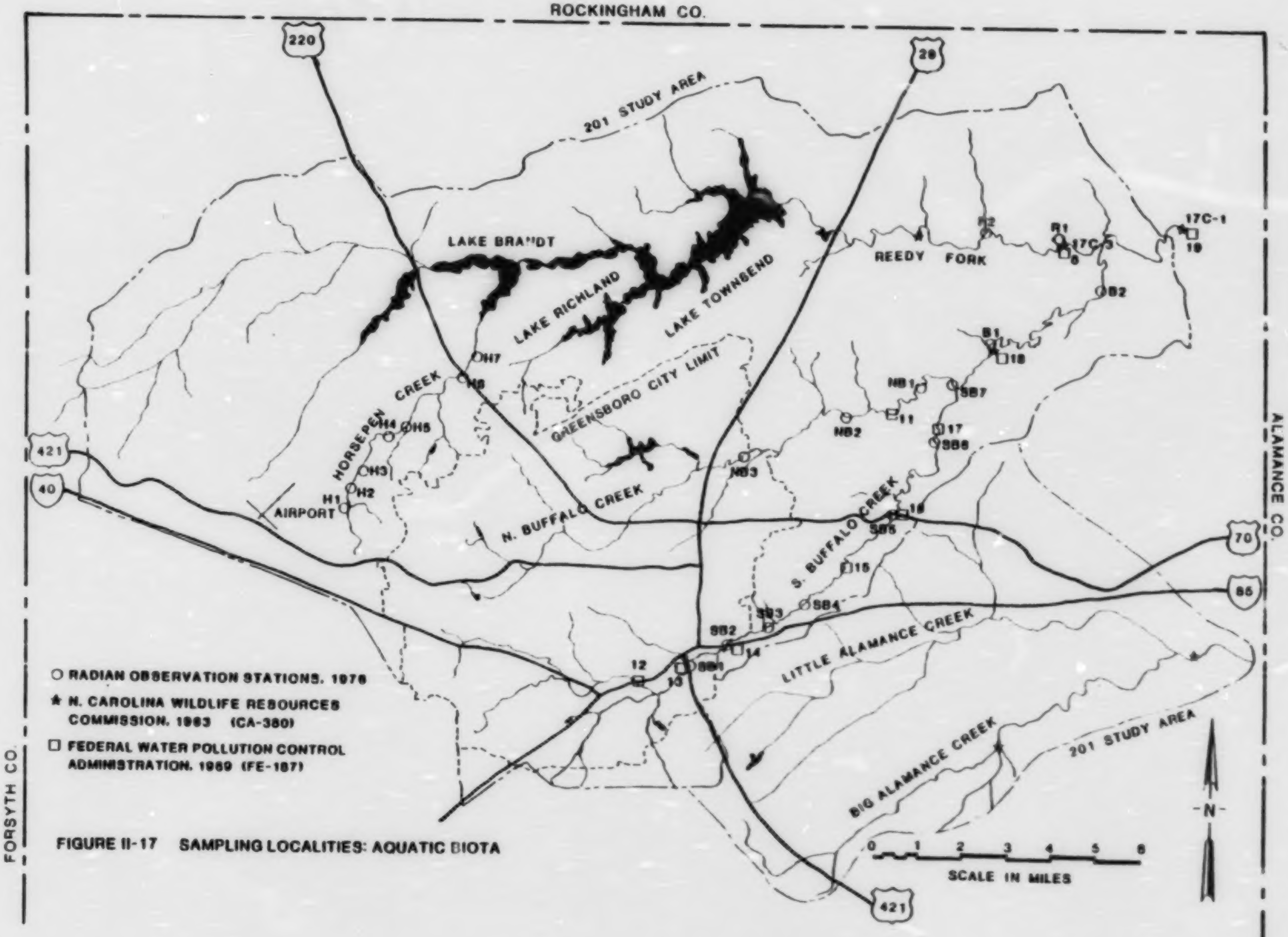

ROCKINGHAM CO.
ALAMANCE CO.
FORSYTH CO.
220
29
421
40
70
85
201 STUDY AREA
LAKE BRANDT
LAKE RICHLAND
LAKE TOWNSEND
REEDY FORK
GREENSBORO CITY LIMIT
HORSEPEN CREEK
N. BUFFALO CREEK
S. BUFFALO CREEK
LITTLE ALAMANCE CREEK
BIG ALAMANCE CREEK
AIRPORT
H1
H2
H3
H4
H5
H6
H7
NB1
NB2
NB3
SB1
SB2
SB3
SB4
SB5
SB6
SB7
B1
B2
R1
R2
17C-1
17C-5
8
11
12
13
14
15
16
17
18
19
○ RADIAN OBSERVATION STATIONS, 1976
★ N. CAROLINA WILDLIFE RESOURCES COMMISSION, 1963 (CA-380)
☐ FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, 1969 (FE-187)
N
0
1
2
3
4
5
6
SCALE IN MILES

FIGURE II-17 SAMPLING LOCALITIES: AQUATIC BIOTA

The upper portions of the creek, as far as Radian Station H5, are narrow (generally less than sixteen feet in width) and alternate between relatively shallow riffles of an inch to a foot in depth and pools of several feet deep. The stream channel is cut to bedrock in the upper portions, and cracking and slumping of the channel sides are evident only where all woody vegetation has been cleared from the banks. The bottom in the upper portion is chiefly small rock and gravel with sands of various sizes. Below Radian Station H5, the stream widens and deepens, silt-size particles become prominent, and the water becomes turbid.

At the point where Horsepen Creek enters Lake Brandt, a small marsh swamp of roughly an acre in size has developed. A brief visit to this marsh was made by Radian biologists, but no detailed observations were made; no other information is available. The bulk of the area is relatively open with mannagrass, bullrush, and cattail the most prominent plants. Alder black willow, and buttonbush, with a few individuals of red maple, form a dense band around the outside of the swampy area, decreasing in density toward the center. Bladderwort and water hyacinth are common in areas of standing water. Mosquito fish were also observed.

The aquatic organisms observed by Radian biologists point to generally healthy conditions in the stream. Caddisfly larvae, generally intolerant of organic pollution, were abundant at nearly all stations, and moderately intolerant dragonfly larvae were found at one station, and filamentous green and blue-green algae were also observed growing on rocks. Although algae were not abundant on the bottom, they were more commonly observed on Horsepen than on the Buffalo Creeks or Reedy Fork; it is likely that the relative clarity of the water and stability of the bottom of Horsepen Creek account for the larger number of algae. Both Hendrickson and Radian biologists noted evidence of a small population of freshwater clams at and about station H5. These have not been identified as to species.

Hendrickson visited Horsepen Creek in 1975 and reported on the vertebrate fauna he found there. Fishes he observed included:

Crescent shiner
River chubsucker
Tesselated darter
Speckled killifish
Piedmont chub

The first of these is noteworthy in that it is known primarily from the Roanoke drainage and occurs in only one other locality in the Cape Fear drainage. The species is not, however, considered endangered. Amphibians observed by Hendrickson included the dusky salamander, green frog, and bullfrog. He also observed a northern water snake during his investigation.

Reedy Fork

The flow of Reedy Fork below Higgins Lake is controlled by the impoundment and release of water from the upstream impoundments. In consequence, flows vary much less in this reach than in the Buffalo Creek system. Radian biologists noted little evidence of flooding or channel erosion, despite recent heavy rains. The bottom was comparatively stable, composed of moderately well imbricated rock and gravel, with sand and some silt (See Figure II-16). Below its confluence with Buffalo Creek, Reedy Fork becomes very rocky with scattered deep pools which provide considerable cover for fish (CA-380).

Water quality in Reedy Fork between Townsend Lake and Buffalo Creek is considered good with mean dissolved oxygen levels measured as 6.8 mg/l by the State of North Carolina (GU-105). Below Buffalo Creek, mean D.O. drops to roughly 4 mg/l, with recorded minima below 1 mg/l (GU-105). This drop in D.O. is generally imputed to B.O.D. input from Buffalo Creek; however, mean D.O. levels in Buffalo Creek four miles above Reedy Fork are recorded as approximately 4 mg/l (GU-105). The lower four miles of Buffalo Creek are rocky with numerous riffles where conditions would be expected to favor reaeration. The mean discharge of Reedy Fork at the confluence is roughly equivalent to the mean discharge of Buffalo Creek. Consequently the low D.O. level downstream of the confluence is difficult to explain on the basis of existing data. Ecologically, this means that the quality of the aquatic habitat the lower portion of Buffalo Creek cannot be inferred, a finding significant to this assessment. The nature of the stream channel suggests that natural reaeration should result in adequate D.O. levels, while the low levels measured downstream in Reedy Fork seem to contradict this assumption.

The Haw-Deep River Survey classifies the stream into the robin-warmouth category above Lake Brandt. Between Townsend Lake and Buffalo Creek it is considered in the largemouth category. Fishing pressure below Lake Brandt is generally light because of limited access and the relatively greater attraction of the lakes. However, the segment of Reedy Fork between Townsend Lake and Buffalo Creek was considered one of the best fishing streams in the Deep-Haw River drainage (CA-380).

Table II-13 lists aquatic organisms recorded by the Deep-Haw River Survey on its two Reedy Fork Stations. The fish samples were taken using rotenone. Two bottom samples were also taken with Ekman dredge at each station. It is readily apparent that the incoming low-quality waters from Buffalo Creek are having a deleterious effect on the fauna. Not only are fish diversity and abundance much lowered, the bottom fauna are dominated by relatively pollution-tolerant oligochaete worms.

TABLE II-13

AQUATIC FAUNA OF REEDY FORK

STATION 17C-3

July 12, 1963

Bottom Organisms (fish foods) in order of abundance:

- Caddisfly larvae
- Mayfly larvae
- True fly larvae

Average number per square foot: 21.5

Ecological Classification: Largemouth[1]

Fish species:

Game

Redbreast sunfish 7-5-0 (230g)[2]
Yellow perch 0-3-0 (50g)
Largemouth bass 0-0-1 (212g)
Bluegill 0-1-0 (48g)
Blackcrappie 0-1-0 (20g)

Non-Game:

Bluehead chub 11-7-0 (228g)
Suckers 0-0-7 (2100g)
Margined madtom 7-0-0 (22g)
Whitefin shiner 4-0-0 (16g)
Johnny darter 3-0-0 (6g)
Piedmont darter 2-0-0 (4g)
Brown bullhead 0-0-2 (100g)
Sandbar shiner 2-0-0 (8g)
Steelcolor shiner 2-0-0 (8g)
Spottail shiner 1-0-0 (4g)

STATION 17C-1

August 8, 1962

Bottom Organisms (fish foods) in order of abundance:

- Segmented worms
- True fly larvae
- Mayfly larvae
- Neuropteran larvae

Average number per square foot: 26.5

Ecological Classification: Catfish-Sucker

Fish species:

Game

Largemouth bass - 1-0-0 (5g)
Bluegill - 1-0-0 (5g)

Non-Game

Brown bullhead - 1-0-0 (5g)

---

[1] See Table 2

[2] First three numbers indicate total individuals of 0-4 in., 4-6 in., and more than six in. length. The number in parentheses is aggregate weight.

Source: CA-380

North Buffalo Creek

As was indicated above, natural flows in North Buffalo Creek are roughly doubled at the North Buffalo treatment plant by the addition of its effluent. Its flows may vary by two orders of magnitude through the years (see section II.A.1.g.). North Buffalo Creek originates in the City of Greensboro, and rapid runoff from its heavily urbanized watershed probably enhances flood flows. Low flows may be maintained largely by effluent from the sewage treatment plant. The aquatic ecosystem is thus subjected both to heavy scouring and extremes of pollution, primarily affecting dissolved oxygen in the water. In addition, flow variability results in a very unstable bottom which affords little opportunity for developing a community of attached organisms. Consequently, it would be unlikely under the present hydrologic conditions that a diverse or abundant aquatic fauna could develop.

As is discussed in more detail in Section II.A.1.g. the industrial and municipal effluents discharged into North Buffalo Creek result in a pronounced lowering of dissolved oxygen content (see Figure II-14). Below Mile 9, average DO falls rapidly from about 8 mg/l to 5 mg/l. Below Mile 8, recent records show that minimum levels fall consistently below 1 mg/l all the way to the confluence. At a single station at mile 4.9, monthly DO readings by the City of Greensboro showed that the most critical time of the year with regard to this parameter was from April through September when levels were consistently below 3 mg/l. Radian biologists visiting North Buffalo Creek in November 1976 noted that the water was black and malodorous with foam below the riffles.

The bottom of North Buffalo Creek consisted chiefly of coarse sands and gravel with some silt and occasional rocks and rubble, and was very unstable at the Radian observation stations (see Figure II-16). A thin layer of black sediment overlay the bottom at that time. The more or less continuously wooded banks below the treatment plant showed evidence of recent flooding, but slumping or cutting of the channel sides were not generally apparent. In the lower portions, the creek flows over several bedrock ridges which create riffles.

The Deep-Haw River Survey in 1963 classified all of the Buffalo Creek drainage as a sewer below the two sewage treatment plants (CA-380). Later, the North Carolina Catalog of Inland Fisheries (FI-137) classified the upstream reaches of North and South Buffalo Creeks as dace trickles (see Table II-12). The reaches from the edge of Greensboro to the confluence of the two forks were classified as robin-warmouth (FI-137). These classifications were made on the basis of hydrological characteristics; no segment of either fork was considered as having any fishing potential as a result of severe pollution.

No fish were observed in North Buffalo Creek by Radian biologists; it was not visited by Hendrickson (HE-214) or sampled for the Deep-Haw River Survey (CA-380). It is possible that mosquitofish, which inhabit the equally polluted South Buffalo Creek could be found in North Buffalo Creek. Radian biologists observed no life whatever in the creek just upstream from the treatment plant, although tracks of raccoon and rat were seen. A riffle at Radian station NB2 yielded a small number of caddisfly larvae and freshwater snails. Station NB3, near the confluence of the two forks, was located near a small bedrock ridge, below which was a large amount of foam. In the well-aerated water and on the stable bottom at this point freshwater snails, caddisfly larvae, and true fly larvae were found, although not in large numbers. The carapace of an eastern box turtle was also found. Very large numbers of dead cranefly pupae were observed cast up along the sides of the channel; living pupae and fragments of pupal cases were also found in large numbers in South Buffalo Creek. Blue-green algae were found infrequently on rocks in quiet waters behind the riffle. The FWPCA samples of benthic organisms from North Buffalo Creek were dominated by the pollution-tolerant tubificid worms, with smaller numbers of bloodworms, sewage-fly larvae, and bristleworms. A few organisms of intermediate tolerance were found at one station.

Altogether, North Buffalo Creek appears to offer only marginal habitat to aquatic life, primarily because of the instability of the bottom and secondarily because of the extreme pollution of its waters. Only in the riffle areas, where there is both a substrate and sufficient dissolved oxygen, is aquatic life observed.

South Buffalo Creek

South Buffalo Creek drains a slightly larger area than North Buffalo, but sewage effluent constitutes 45% of the flow at the treatment plant 50% of the time. As in North Buffalo Creek, very high flows often occur, leaving debris stranded in the overhanging vegetation ten to fifteen feet above the channel bottom. Low flows may drop to a few cfs for several days. Thus, hydrologic instability is again a major impediment to the development of a diverse and healthy ecosystem.

Dissolved oxygen levels in South Buffalo Creek dip sharply following the discharge of effluents from USS Agri Chemicals, Troxler Hosiery, and the South Buffalo treatment plant (see Figure II-11). Mean levels of about 7 mg/l above these discharges drop to roughly 3, make a slight recovery, and fall again at about Mile 4. Below Mile 7, minimum oxygen levels may drop to zero. As with North Buffalo Creek, the lowest levels occur from April to September. A segment of the stream below the treatment plant has been channelized as far as U.S. Highway 70, which permits oxygen-demanding materials to move quickly away from their source. Following the channelized portion, however, the stream follows a meandering course to about a mile above the confluence in which its velocity slows considerably. While no water quality stations exist within this stream segment, it is reasonable to assume that a D.O. sag would be measured there, resulting from the oxidation of pollutants originating upstream.

South Buffalo Creek is widely recognized as poor quality water downstream of Greensboro. Radian biologists found the water and sediments slightly to moderately madodorous, usually with the typical small of organic decay.

Above the channelized portion and continuing through it, the stream bottom is characterized by a very plastic clay which has almost the texture of soft stone when wet and can be walked on without sinking. Low ridges or benches of this clay constitute such riffles as exist above the channelized reach. Between them, sediments are principipally fine sands and silts with occasional gravelly shoals, all very unstable. Although the streambed it self is often clayey, the channel sides are generally composed of a friable sand, and commonly show localized cutting and slumping. Roughly at the point where Harvest Road crosses the stream, large rocks appear in the channel and the stream flows over successive bedrock ridges as far as the confluence.

The Deep-Haw River Survey included a station on Buffalo Creek (Station 17C) but recorded no fish in spite of using rotenone. No sample was taken of bottom organisms. Radian biologists found that bottom organisms were present at almost all sites, although they were nowhere abundant and the majority encountered were pollution-tolerant taxa. As in North Buffalo Creek, the bulk of the organisms found were in riffle areas. Some caddisfly larvae were found, but most invertebrates were of such pollution-tolerant forms as bloodworms and sludge worm. One species of annelid worm (tentatively identified as Aelosoma) was found above and below the channelized portion, and mixtures of green and blue-green algae were found where rocks or clay hardpan afforded a stable attachment site. About 8 km above the confluence of the two forks, red and orange-colored floc, assumed to be of bacterial origin, was observed in backwater areas. The most varied aquatic life was found just above the confluence probably reflecting the larger proportion of rock in the channel and the consequent aeration of the water. Dragonfly larvae, caddisfly larvae and freshwater snails were observed along with bloodworms. Remains of an unidentified crayfish were also found. No rooted aquatic plants were seen. These observations corroborate the data from the FWPCA study which found only tubificid worms in the five stations sampled.

Both Hendrickson (HE-214) and Radian biologists observed mosquitofish in South Buffalo Creek, and Hendrickson also reported an unidentified cyprinid minnow in the lower portion of the creek. He also reported that frogs are abundant and suggested that these and the snails provide food for herons and raccoons. Water snakes have been reported for the area, but none were seen by either group of investigators, probably because of the timing of the site visits. Hendrickson observed both river cooter (a turtle) and eastern box turtle, as well as fence lizard, along South Buffalo Creek (HE-214).

The general observations made by Hendrickson and Radian suggest that the least favorable habitat conditions in the stream may exist in the channelized portion and the slow-moving segment just below. Conditions above and below this stretch seem more favorable to aquatic life, judging from the field observations.

Below the confluence of the two forks of Buffalo Creek, as far as Reedy Fork, flows continue to be influenced by upstream urban runoff patterns and municipal wastewater discharge, although runoff from non-urban portions of the watershed progressively dilutes the contaminated upstream flows. Water quality data are available only 2 miles below the confluence of North and South Buffalo Creeks; measurements there show D.O. at a mean level of 4 mg/l. The streamcourse from that point is meandering and rock, and it would be reasonable to suppose that reaeration brings this level even higher before the water flows into Reedy Fork, barring additional BOD input.

Alamance Creek

Flow in Big Alamance Creek, 1.5 miles below the Alamance-Guilford County boundary, exceeds 79 cfs 50% of the time, with flood flows of more than 1120 cfs (exceeded 2% of the time) and low flows of 1 cfs or less (exceeded 99.5% of the time).

The available information base for the Alamance Creek system is scanty. Water quality records are unavailable. A Radian biologist has made general observations of aquatic habitat quality on those portions of the drainage which might be affected by the proposed treatment system. Information on the stream's fish populations is drawn from the Deep-Haw River Survey (CA-380) and the North Carolina Wildlife Resources Commission's Catalog of Inland Fisheries Resources (FI-137) complemented by some incidental observations by Hendrickson (HE-216). In addition, the Federal Water Pollution Control Administration (FE-187) sampled bottom fauna at two stations.

The Alamance Creek system consists of Little and Big Alamance Creeks, which join to form Great Alamance Creek, which flows into the Haw River. Little and Big Alamance Creeks are classified into the Haw River. Little and Big Alamance Creeks are classified as robin-warmouth streams, while Great Alamance is considered a catfish-sucker stream. The combined observations of Hendrickson, Radian and the Deep-Haw Survey are summarized in Table II-14.

TABLE II-14

AQUATIC FAUNA OF BIG ALAMANCE CREEK

STATION 17C-5

July 12, 1963

Bottom Organisms (fish foods):

- Mayfly larvae
- Aquatic beetles
- Segmented worms
- Caddisfly larvae
- True fly larvae

Average number per square foot: 7.0

Ecological Classification:
Robin-warmouth

Fish species:

Game

- Redbreast 4-1-0 (82g)
- Largemouth bass 1-1-2 (218g)
- Bluegill 2-0-0 (12g)
- *Silver redhorse
- *Smallfin redhorse
- *Bluegill
- *Pumpkinseed

Non-game:

- Bluehead chub 13-1-0 (72g)
- Piedmont darter 6-0-0 (8g)
- Margined madtom 2-3-0 (32g)
- Sandbar shiner 5-0-0 (15g)
- Johnny darter 2-0-0 (4g)
- Steelcolor shiner 2-0-0 (6g)
- Pirate perch 1-0-0 (trace)
- *Satinfin shiner

Sources: CA-380 pt. 2; HE-216

*Observed separately by Hendrickson

The river is dammed three times between Reedy Fork and Saxapahaw; two of these dams have been breached by flooding. Because of the effect of the dams on the width and depth of the river, it is classified as either a catfish-sucker type (shallower reaches) or a carp-catfish type (impoundments and deeper waters). Above Reedy Fork, the Haw River supports a modest catfish and sunfish sport fishery. Between Reedy Fork and Alamance Creek, the stream is considered too polluted to support a sport fishery (FI-137).

Table II-15 lists phytoplankton found in the Saxapahaw Impoundment (FE-187). This type of community can also be expected in the slower-moving upstream areas.

Lake Brandt

At the present time, comparatively little information is available on the aquatic ecosystem of Lake Brandt. The information presented here was furnished by Scott Van Horn of the North Carolina Wildlife Resources Commission (VA-157).

Lake Brandt was built in 1921 and expanded to its present size of 810 surface hectares in 1960. The lake has a mean depth of 36 feet and stratifies in summer with the thermocline at about 13 feet. Temperatures measured in July, 1969 were 88°F at the surface and 65°-76°F below the thermocline. Dissolved oxygen was adequate in the surface layer (8 mg/l) but greatly depleted below the thermocline (0-1.5 mg/l).

The shallower portions of the lake, especially the mouth of Horsepen Creek and Reedy Fork as it enters the lake, become choked in summer with extensive beds of water lilies and pondweeds of various kinds. No information is available regarding algae found in the lake or the extent to which spring and/or fall turnover influences their abundance. Table II-16 lists fish found in

TABLE II-1½

PHYTOPLANKTON DATA - HAW RIVER IMPOUNDMENT AT SAXAPAHAW, N. C.

PHYTOPLANKTON DATA HAW RIVER IMPOUNDMENT AT SAXAPAHAW, N. C.

		AUGUST 16, 1969			AUGUST 17, 1969			SEPTEMBER 12, 1969	
ALGAE	STATION L-4 C/mL	STATION L-3 C/mL	STATION L-1 C/mL	STATION L-4	STATION L-3	STATION L-1	STATION L-4	STATION L-3	STATION L-1
Coccoid blue green									
Anacystis cyanea	3,303	2,774	8,122	3,669	1,002	3,091	2,290	3,032	4,004
Anacystis dimidiata	86								
Total	3,389	2,774	8,122	3,669	1,002	3,091	2,290	3,032	4,004
Filamentous blue-green									
Anabaena sp.	57	29	143		29	29	29	114	86
Total	57	29	143		29	29	29	114	86
Coccoid green									
Actinastrum sp.			29						
Ankistrodesmus sp.	57	172	229	143	229	315	114	86	143
Chlorella sp.	5,291	1,430	315	3,375	915	5,291	600	257	1,115
Coelastrum sp.	29				29	86			
Eudorina sp.		172			86				
Gonium sp.					200				29
Oocystis sp.			29						
Scenedesmus sp.	86						29	29	
Tetraedron sp.							29	29	
Total	5,463	1,774	800	3,718	1,430	5,692	802	401	1,306
Chlamydomonas sp.	1,144	715	2,803	4,290	572	1,430	286	629	1,316
Euglena sp.		114	114			29	29		114
Phacus sp.	86	229	172		114	57	86	86	57
Total	1,230	1,058	3,089	4,290	686	1,545	401	715	1,487
Other pigmented Flagellates									
Trachelomonas sp.	686	57	143		29		29	29	29
Total	876	57	143		29		29	29	29
Live centric diatoms		143	29	114	57	172	315	229	57
Live pennate diatoms							57		
Total Live algae	10,725	3,835	12,320	11,811	4,062	12,529	6,121	4,520	7,179

Source: FE-187

the lake. Fishing on the lake is popular, although permitted only from city-owned boats. Lack of forage species has been a problem in Lake Brandt, and threadfin shad were introduced in 1967 and 1969. Fish from these stocks winterkilled, but restocking in 1972 seemed to produce a surviving population. Because of low availability of forage fish, largemouth bass are small and slow-growing.

TABLE II-16

FISHES OF LAKE BRANDT

Game Fish	
[1] Pumpkinseed	Lepomis gibbosus
[1] Bluegill	Lepomis macrochirus
[1] Black crappie	Pomoxis nigro-maculatus
White crappie	Pomoxis annularis
Yellow perch	Perca flavescens
Redbreast sunfish	Lepomis auritus
Warmouth	Chaenobryhus gulosus
Green sunfish	Chaenobryhus cyanellus
[3] Chain pickerel	Esox niger
[2] Largemouth Bass	Micropterus salmoides
[3] White bass	Morone chrysops
Non-Game Fish	
[1,2] Yellow bullhead	Ictalurus natalis
Brown bullhead	Ictalurus nebulosus
Black bullhead	Ictalurus melas
Flat bullhead	Ictalurus platycephalus
[1,2] White catfish	Ictalurus catus
[1] Channel catfish	Ictalurus punctatus
[2] Carp	Cyprinus carpio
Goldfish	Carassius auratus
Golden Shiner	Notemigonus chrysoleucas
[3] Threadfin shad	Dorosoma petenense
[3] Blueback herring	Alosa aestivalis

---

[1] Major species by weight (Source: VA-157)

[2] Major species by number (Source: VA-157)

[3] Stocked but possibly not surviving over winter

B. Man-Made Environment

1. Demography and Economics

a. Current Population Data

This section discusses population (number of inhabitants) for the EIS Study Area and six components of the population; namely, age distribution, racial distribution, households, average household income distribution, and employment within the area. Supporting documentation including breakdowns by census tracts and methodologies used herein may be found in the Technical Reference Document (RA-R-406).

(1) Number of Inhabitants

As reported in the 1970 census, there were 288,645 people in Guilford County, of which 144,076 people, or 49.9 percent, were within the City of Greensboro. Table II-17 compares the city and county population to that of the state and nation. Guilford County has consistently outpaced the state and nation in percentage increase of population since the early 1900's.

The OBERS population for the Greensboro-Winston Salem-High Point, North Carolina Standard Metropolitan Statistical Area (SMSA) was disaggregated by the Department of Natural and Economic Resources, Raleigh, North Carolina (US-528). In 1960, the estimated OBERS population for the 201 Study Area was 161,316 people. By 1970, there were 191,432 people and in 1975, the population was 193,871 people. These figures represent 18.7 and 1.2 percentage increases in population for the 1960-1970 and 1970-1975 periods.

TABLE II-17

POPULATION TRENDS FOR VARIOUS AREAS, 1900 - 1970

	United States		North Carolina		Guilford County		Greensboro	
Year	Population	% Change	Population	% Change	Population	% Change	Population	% Change
1900	76,212,168	----	1,893,810	----	39,074	----	10,035	----
1910	92,228,496	21.0	2,206,287	16.5	60,497	54.8	15,895	58.4
1920	106,021,537	14.9	2,559,123	2.4	79,272	31.0	19,861	24.9
1930	123,202,624	16.2	3,170,276	23.9	133,010	67.8	53,569	169.7
1940	132,164,569	7.3	3,571,623	12.7	153,916	15.7	59,319	10.7
1950	151,325,798	14.4	4,061,929	13.7	191,057	24.1	74,389	25.4
1960	179,323,175	18.5	4,458,000	9.8	246,520	29.0	121,591	63.4
1970	203,211,926	13.3	5,091,000	14.2	288,645	20.2	144,076	18.5

Source: US-660
US-661
US-662

The OBERS disaggregation for the 201 Area has been adjusted because 100 percent of the population of census tracts 119.01, 121, 124.02, 128.02, 129, 132, 133.01, 133.02, and 134.01 was originally included. Portions of these tracts are beyond the 201 Study Area. Through the use of land use maps and aerial photographs, the population within these tracts that is outside of the Study Area was calculated and subtracted from the totals. Also, an area not included in the environmental assessment has been added to the Alamance subbasin. Original OBERS disaggregations did not include the additional area.

Table II-18 shows the 1970 and 1975 population and acreage by planning subbasin. Further details on the methodology used to calculate 1970 and 1975 population may be found in the Technical Reference Document (RA-R-406).

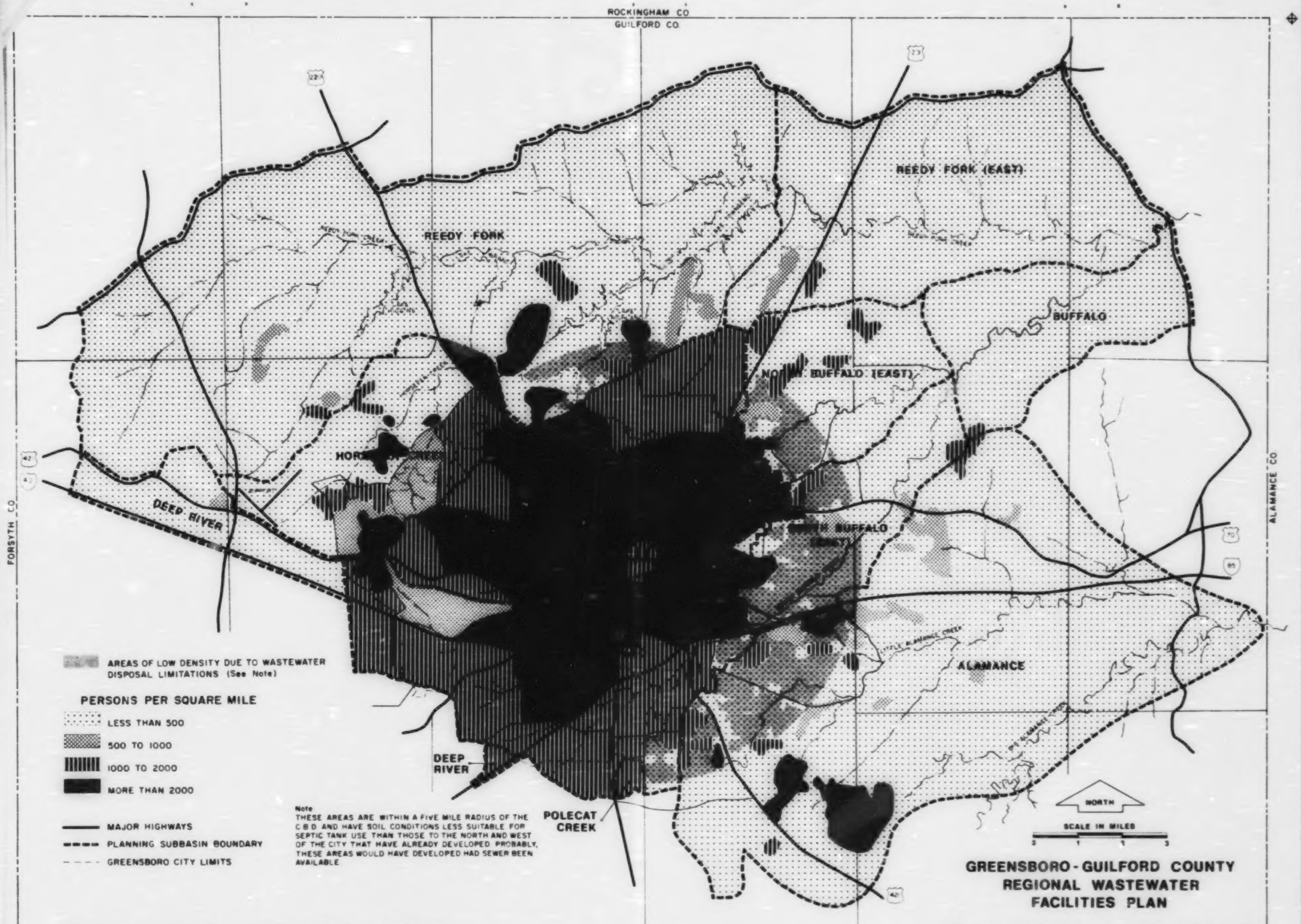
The Study Area had a population of 185,360 people in 1970 and 196,617 people in 1975. North and South Buffalo subbasins contain the majority of the population (77.7 percent). The city limits of Greensboro fall mostly within these two planning areas. Density varies from basin to basin. The Hazen and Sawyer Environmental Assessment (HA-544) demonstrated, and 1960 and 1970 census tract statistics show, a declining central city and a decline along a westerly axis through the city. Slight growth has occurred in the northern edge of the city with significant increases occurring in the peripheral areas. For some period of time, most growth has occurred in a westerly direction. Figure II-18 shows population density within the Study Area. Density was calculated by census tracts except in areas where census tracts are large. In these areas, building permit data, land use maps, and aerials were used to determine density.

TABLE II-18

1970 AND 1975 POPULATION AND ACREAGE BY PLANNING SUBBASIN

Subbasin	1970 Population	1975 Population	Acreage Within Subbasin
Reedy Fork	8,811	10,729	52,896
Deep River	588	596	4,294
Horsepen Creek	7,552	8,080	11,021
North Buffalo	83,519	85,539	20,403
South Buffalo	64,032	67,327	19,738
Reedy Fork (East)	2,761	2,857	21,811
North Buffalo (East)	2,677	3,147	8,570
South Buffalo (East)	3,105	3,670	7,635
Alamance	10,935	13,169	44,787
Buffalo	1,380	1,503	8,986
TOTAL	185,360	196,617	200,141

Source: GR-272


ROCKINGHAM CO
GUILFORD CO
FORSYTH CO
ALAMANCE CO
220
29
42
421
70
85
REEDY FORK
REEDY FORK (EAST)
BUFFALO
NORTH BUFFALO (EAST)
NORTH BUFFALO (WEST)
HORSE PEN CREEK
DEEP RIVER
DEEP RIVER
POLECAT CREEK
ALAMANCE
LITTLE ALAMANCE CREEK
AREAS OF LOW DENSITY DUE TO WASTEWATER DISPOSAL LIMITATIONS (See Note)
PERSONS PER SQUARE MILE
LESS THAN 500
500 TO 1000
1000 TO 2000
MORE THAN 2000
MAJOR HIGHWAYS
PLANNING SUBBASIN BOUNDARY
GREENSBORO CITY LIMITS
NORTH
SCALE IN MILES
0
1
2
3

Note
THESE AREAS ARE WITHIN A FIVE MILE RADIUS OF THE C.B.D. AND HAVE SOIL CONDITIONS LESS SUITABLE FOR SEPTIC TANK USE THAN THOSE TO THE NORTH AND WEST OF THE CITY THAT HAVE ALREADY DEVELOPED. PROBABLY, THESE AREAS WOULD HAVE DEVELOPED HAD SEWER BEEN AVAILABLE.

POPULATION DENSITY 1975

GREENSBORO - GUILFORD COUNTY
REGIONAL WASTEWATER
FACILITIES PLAN

ERIC HILL ASSOCIATES
ATLANTA, GA

PLANNING CONSULTANTS
WINSTON - SALEM, N.C.

(2) Age Distribution

In addition to the steady increase in population, the composition of the population has changed. Table II-19 compares the age distribution of the Study Area with the nation, state, and county. An assumption was made that the EIS Study Area and Guilford County have similar percentages of age distribution because the Study Area encompasses such a large percentage of the county.

The population of Guilford County is aging somewhat. Table II-19 shows that younger cohorts had relatively smaller percentages of the population in 1970 compared to 1960. Also, the older cohorts (over 40) had grown in relative size.

(3) Racial Distribution

Table II-20 shows the black population by planning subbasin. Based on block data, there were 44,990 blacks within the EIS Study Area in 1970. However, this number may be less than the actual number because some data were suppressed when the percentage was too small to be shown. The South Buffalo subbasin contains the largest number of blacks (64 percent of the total). Ninety-two percent of the total number of blacks live in the South Buffalo and North Buffalo subbasins. A breakdown by census tracts and subbasins is found in the Technical Reference Document (RA-R-406).

(4) Households

Increases in the number of households have definitely been occurring on the fringes of the city (see Table II-21).

TABLE II-19

AGE OF POPULATION BY AGE GROUP AND AREA, 1960 AND 1970

	United States		North Carolina		Guilford Co.		EIS Area	
	Number	%	Number	%	Number	%	Number	%
1960								
0-19	69,084,404	38.6	1,929,240	42.3	98,546	40.0	64,526	40.0
20-39	46,133,576	25.7	1,227,725	26.9	72,177	29.3	47,266	29.3
40-64	47,900,440	26.7	1,087,023	23.9	60,770	24.6	39,684	24.6
65+	16,176,687	9.0	312,167	6.9	15,027	6.1	9,840	6.1
TOTAL	179,325,657	100.0	4,556,155	100.0	246,520	100.0	161,316	100.0
Median Age	29.5		25.5		27.0		27.0	
1970								
0-19	76,970,400	--	1,979,871	39.0	110,191	38.1	70,622	38.1
20-39	52,385,301	--	1,387,450	27.3	81,005	28.1	52,086	28.1
40-64	53,790,723	--	1,300,489	25.6	75,031	26.0	48,194	26.0
65+	20,065,502	--	414,249	8.1	22,363	7.8	14,458	7.8
TOTAL			5,082,059	100.0	288,590	100.0	185,360	100.0
Median Age	28.1		26.5		27.0		27.0	

Source: US-557
US-558
US-559

TABLE II-20
1970 BLACK POPULATION BY PLANNING SUBBASINS

		1970 Black Population
Reedy Fork		463
Deep River		40
Horsepen Creek		296
North Buffalo		12,630
South Buffalo		28,752
Reedy Fork (East)		754
North Buffalo (East)		383
South Buffalo (East)		686
Alamance		884
Buffalo		102
	Total	44,990

Source: US-664

Large increases have occurred in Alamance, Reedy Fork, and Horsepen Creek. A careful examination of the North and South Buffalo subbasins shows that increases fluctuate within the subbasins. The largest increases occurred along the northernmost edge of North Buffalo and along the southernmost edge of South Buffalo. A breakdown by census tracts and subbasins can be found in the Technical Reference Document (RA-R-406).

(5) Income

Per capita income increased significantly within the Study Area between 1969 and 1974. All subbasin areas showed at least a 13 percent increase (Table II-22). Deep River, Horsepen Creek, and Reedy Fork showed the largest increases.

TABLE II-21

1970 AND 1975 (ESTIMATED) HOUSEHOLDS BY PLANNING SUBBASINS

	1970 Households Within Subbasin	1975 (Estimated) Households Within Subbasin	Change	
			Number	Percent
Reedy Fork	2,545	3,377	832	32.7
Deep River	175	181	6	3.4
Horsepen Creek	2,093	2,738	645	30.8
North Buffalo	26,471	28,660	2,189	8.3
South Buffalo	18,548	20,633	2,085	11.2
Reedy Fork (East)	780	859	79	10.1
North Buffalo (East)	875	1,025	150	17.1
South Buffalo (East)	916	1,170	254	27.7
Alamance	3,016	3,892	876	29.0
Buffalo	389	449	60	15.4
Total	55,808	62,984	7.176	12.9

Source: GR-272

TABLE II-22
AVERAGE PER CAPITA INCOME BY PLANNING SUBBASINS

	Average Per Capita Income		Change	
	1969	1974*	Number	Percent
Reedy Fork	$ 2,791	$ 4,361	1,570	56.2
Deep River	2,847	5,228	2,381	83.6
Horsepen Creek	3,393	5,655	2,262	66.7
North Buffalo	4,337	6,234	1,897	43.7
South Buffalo	2,699	3,513	814	30.1
Reedy Fork (East)	2,249	2,546	297	13.2
North Buffalo (East)	2,557	2,960	403	15.8
South Buffalo (East)	2,470	3,032	562	22.8
Alamance	2,694	3,316	622	23.1
Buffalo	2,639	3,162	523	19.8

*Estimated

NOTE: Average Per Capita Income calculated by finding the average per capita income of those census tracts within each subbasin.

Source: GR-291

The distribution of households by income follows a definite pattern. The eastern portion of the Study Area and the areas along either side of the Southern Railway running east-west through Greensboro have annual household incomes of less than $10,000. The southernmost and northwestern portions of the Study Area have the higher incomes.

In 1970, Greensboro's median income was $10,166, which was above that of North Carolina ($7,774) and the United States ($9,590). Around 18 percent of Greensboro's households earn less than $5,000 annually.

(6) Employment

Paralleling the steady population growth of the city and county has been an increase in the number of persons employed. Between 1970 and 1974, almost 20,000 new jobs were created within Guilford County. Unemployment fluctuated within the county from a high of 3.8 percent in 1971 to a low of 2.6 percent in 1972 and 1973. In 1975, however, the Greensboro-High Point-Winston Salem SMSA was reported to have an unemployment rate of 7.8 percent. Although data are not available for 1974-1976, Greensboro-Guilford County experienced an economic slump common in many areas of the country in that period.

Table II-23 shows a breakdown of non-farm employment by industry group for Guilford County during 1970 and 1974. The greatest numerical growth was in Service and Miscellaneous followed by Wholesale and Retail Trade. These two categories absorbed almost 56 percent of the growth of the county. Manufacturing continued to have the largest proportion of employment, while Wholesale and Retail Trade continued to share approximately 20 percent of total employment.

b. Current Economic Conditions

The Greensboro urbanized area has recently experienced net gains in both manufacturers and retail stores. Tables II-24 and II-25 show the breakdowns by subbasins within the EIS Study Area for new manufacturing locations by number of employees and retail openings and closings. North and South Buffalo continue to not only attract the greatest number of new manufacturers but also the largest (101+ employees) employers. At the same time, these subbasins have had the largest numbers of retail openings and closings and the largest number of net gains within the Study Area.

TABLE II-23

NON-FARM EMPLOYMENT BY INDUSTRY GROUP FOR GUILFORD COUNTY, 1970,1974

Category	Employees		Change	
	1970	1974	Number	Percent
Manufacturing:				
• Food	2,870	2,730	- 140	- 4.9
• Textiles	20,010	20,550	540	2.7
• Apparel	4,790	4,670	- 120	- 2.5
• Paper	1,820	1,460	- 360	-19.8
• Printing	2,050	2,290	240	11.7
• Chemicals	1,900	2,530	630	33.1
• Other	25,140	26,850	1,710	6.8
Total Manufacturing	58,580	71,080	2,500	4.3
Non-Manufacturing:				
• Construction	8,930	10,460	1,710	19.1
• Transportation, Communication, Public Utilities	6,660	7,270	670	10.2
• Wholesale & Retail Trade	28,990	34,280	5,290	18.2
• Finance, Insurance, Real Estate	7,670	8,960	1,290	16.8
• Service & Miscellaneous	16,430	21,860	5,430	33.0
• Government	15,730	18,080	2,350	14.9
Total Non-Manufacturing	84,350	·101,090	16,740	19.8
TOTAL NON-FARM	142,930	162,170	19,240	13.5

Source: NO-119

TABLE II-24
NEW MANUFACTURING LOCATIONS WITHIN THE EIS STUDY AREA, 1970-1975, BY SUBBASIN, AND NUMBER OF EMPLOYEES

Subbasin	1-10	11-100	101+	Total New Manufactures
Reedy Fork	--	--	--	--
Deep River	--	1	2	3
Horsepen Creek	--	3	--	3
North Buffalo	51	15	1	67
South Buffalo	31	27	5	63
Reedy Fork (East)	--	--	--	--
North Buffalo (East)	--	--	--	--
South Buffalo (East)	--	--	--	--
Alamance	--	--	--	--
Buffalo	--	--	--	--
Total	82	46	8	136

Source: GR-293

TABLE II-25
RETAIL OPENINGS AND CLOSINGS WITHIN THE EIS STUDY AREA, 1970-1975, BY SUBBASIN

	1970 - 1975		
Subbasin	No. of Openings	No. of Closings	Net Gain (+) Net Loss (-)
Reedy Fork	1	5	- 4
Deep River	1	--	+ 1
Horsepen Creek	11	5	+ 6
North Buffalo	263	196	+67
South Buffalo	161	108	+53
Reedy Fork (East)	3	2	+ 3
North Buffalo (East)	4	1	+ 3
South Buffalo (East)	8	3	+ 5
Alamance	4	1	+ 3
Buffalo	--	--	--
Total	456	321	+135

Source: GR-292

Major revenue producers and employers are shown in Table II-26. For each, the 1976 assessed valuation for real property was calculated and the total revenue produced. Two factors should be noted. First, manufacturing firms not only constitute a major portion of the highest employers within the county but also contribute significant revenue to the economy. Second, although services such as governments, hospitals, and colleges are major employers, they are exempt from property tax (see Table II-26).

c. Population Projections

In preparing population projections for the EIS Study Area, projections by OBERS for the Standard Metropolitan Statistical Area (SMSA), as disaggregated by the North Carolina Division of Environmental Management (NCDEM), projections by the Greensboro Planning Department for the "701" Study Area (which closely coincides with the EIS Study Area), and projections in the Hazen and Sawyer Environmental Assessment (HA-544) were carefully analyzed. Of most importance was the directive by the Environmental Protection Agency (EPA) that base projections be made assuming that sewage is not a constraint to development. Therefore, projections were made assuming that sewer services would be available throughout the Study Area. Existing land use data, number of building permits from 1970 to 1975, and environmentally sensitive lands were other critical considerations in the projections. The first step undertaken was to determine population projections and land use projections for the entire Study Area. For land use, population was converted to number of dwellings, single-family and multi-family components, and acres of residential land needed. Finally, population and land use were allocated to the subbasins.

Several assumptions were made in the projections:

TABLE II-26

NUMBER OF EMPLOYEES, ASSESSED VALUATION, AND REVENUE PRODUCED FOR THE MAJOR REVENUE PRODUCERS AND EMPLOYERS, GUILFORD COUNTY, BY INDUSTRY TYPE

Name of Firm	Estimated Number of Employees	1976 Assessed Valuation*	Revenue Produced	Revenue Per Employee
Manufacturing:				
Cone Mills Corp.	5-6,000	$25,097,040	$381,100	$ 69.29
Lorillard	3,000	9,611,380	162,913	54.30
Burlington	2,300	26,604,915	381,051	165.67
Guilford Mills	1,000+	5,721,128	68,712	68.71
J.P. Stevens	1,000	4,789,290	75,256	75.26
Blue Bell, Inc.	2,000	3,602,270	58,120	29.06
Carolina Steel	500+	4,130,110	55,639	111.28
Gilbarco Corp.	1,005	5,837,770	43,199	42.98
Greensboro Manu.	1,000+	--	—	—
Bates Nitewear	500+	213,550	3,620	7.24
Ciba-Geigy	650+	10,209,250	75,548	116.23
Transportation, Communication, Public Utilities:				
Duke Power Company	281	99,875,670	**	—
Piedmont Natural Gas	150+	21,875,670	**	—
Southern Bell	1,200	113,750,982	**	—
Southern Railway	100+	16,568,127	**	—
Western Electric	1,500+	15,295,950	125,627	83.75
Wholesale & Retail Trade:				
Sears, Roebuck	2,200	18,983,710	320,041	145.47
Finance, Insurance, Real Estate				
Jefferson Standard Life	600+	11,195,050	182,298	303.83
Services:				
Moses H. Cone Memorial	1,000+	Exempt	—	—
N.C.A. & T Univ.	840+	Exempt	—	—
Federal Post Office	800	Exempt	—	—
Wesley Long Hospital	520	Exempt	--	--
U.N.C. Greensboro	1,000+	Exempt	—	—
Greensboro City Schools	2,600	Exempt	—	—
City of Greensboro	2,613***	Exempt	—	—
Guilford County	1,854	Exempt	—	—

---

*Assessed valuation only for real property. Personal property not included.

**Assessed valuation is determined by the state for public utilities and includes real and personal property. For the entire county, the valuation of all public utilities is $340,271,158. Total revenue paid is $2,949,325.

***Of these employees, 1,887 are permanent.

Source: GR-294
GU-106

(1) Population was converted to dwelling units by dividing by an average household size (HA-544): 2.2 for multi-family units and 3.0 for single-family units. Based on discussions with the Greensboro Planning Department, the factor for multi-family units was lowered to 2.0 (BR-358).

(2) As in the Environmental Assessment (HA-544), dwelling unit requirements were converted to residential acreage by using an average gross density of ten dwelling units per acre for multi-family housing units and two dwelling units per acre for single-family housing. These figures are consistent with those now being used by the Greensboro Planning Department.

(3) The breakdown of population into multi-family and single-family components, by five-year intervals, was prepared and coordinated with the Greensboro Planning Department and is similar to those figures used in the Environmental Assessment (HA-544). Details of this breakdown are found in the Technical Reference Document (RA-R-406).

(4) To reiterate, sewer service is assumed where growth is projected. Available capacities and constraints on the system were not assumed as deterrents to growth.

Table II-27 shows the population projections by the Bureau of Economic Analysis, OBERS (Series E), the Greensboro Planning Department, and the Environmental Assessment (HA-544). Projections used herein are those of OBERS (Series E) as disaggregated

TABLE II-27

POPULATION PROJECTIONS, 1970-2000, BY OBERS GREENSBORO PLANNING DEPARTMENT, HAZEN AND SAWYER, AND RADIAN[1]

	BEA Data		OBERS (Series E)	Greensboro Planning Dept.		Hazen & Sawyer	Radian
	SMSA	Guilford County	EIS Study Area[2]	701 Planning Area	Greensboro	201 Study Area	EIS Study Area
1970	724,576	296,200[3]	191,423	185,397	144,076	166,430[5]	185,360
1975	NA	299,300[4]	213,500	196,771	153,995	175,160	196,617
1980	831,400	327,500	227,600	212,570	162,887	194,960	227,600
1985	NA	NA	NA	234,086	176,617	213,670	245,050[6]
1990	963,300	375,600	262,500	257,505	191,362	234,130	262,500
1995	NA	NA	NA	279,100	203,564	249,380	274,850[6]
2000	1,060,900	412,100	287,200	299,138	213,668	265,620	287,200

---

[1] Except for 1970 and 1975, data are same as OBERS (Series E) disaggregation from NCDEM.

[2] These data were disaggregated from OBERS Series E by NCDEM by applying a projection factor based on 1960 and 1970 population within the 201 Study Area and similar county population data.

[3] OBERS data are actually for 1972.

[4] OBERS data for 1974.

[5] Data provided are for 1973.

[6] Midpoint between 1980 and 1990, and 1990 and 2000.

Source: US-560
GR-291
HA-544

by NCDEM, except for 1970 and 1975 population. As discussed in an earlier section of this report, these numbers appear to be high and, therefore, were recalculated, using census tract and block data. However, other projections appear to be acceptable. Projections are higher than those in the Environmental Assessment (HA-544) because of the increase in the Study Area, but are compatible with figures not yet released by the Greensboro Planning Department. Since OBERS did not project for 1985 and 1995, a midpoint figure was used for these years.

From these totals, projections were broken down by subbasin for five-year intervals for the year 2000. Emphasis was placed on the allocation of population by subbasins for the year 2000 (Table II-28). The methodology used is presented in the Technical Reference Document (RA-R-406).

Population growth from 1975-2000 is also shown in Table II-28. North and South Buffalo will continue to have a major influence on the total growth. North Buffalo (East) and South Buffalo (East) will undergo significant growth.

Population density in the year 2000 is shown in Figure II-19. The urban area will continue to expand; areas to the north, east, and south will increase substantially in density. Some redevelopment within the central city is anticipated with density increases. Generally, the areas shown in the year 2000 are the same as those of the Greensboro Planning Department,[1] given sewage east of the present city limits.

Projected population characteristics were also determined for the Study Area. These include age distribution, per

---

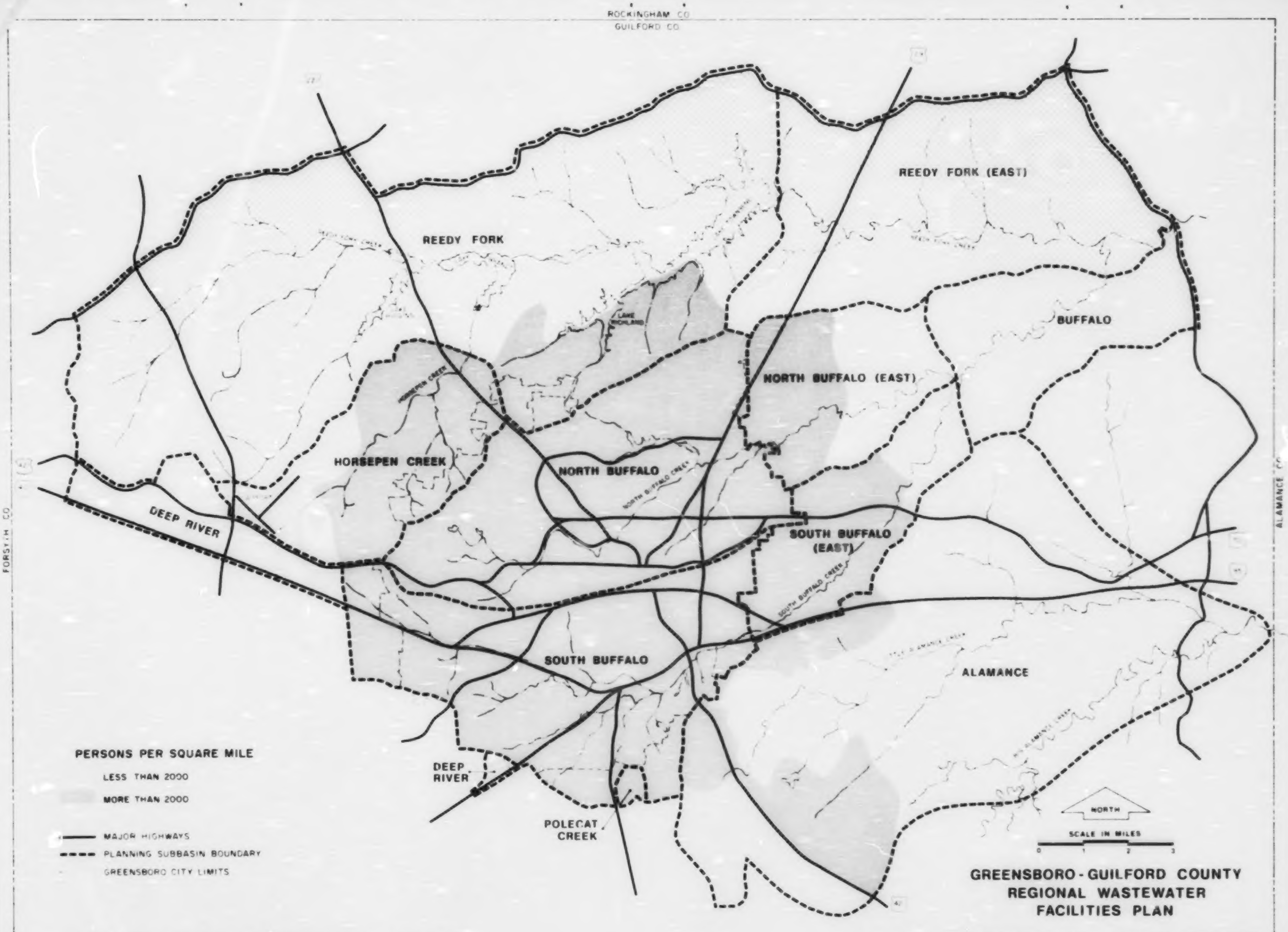
[1] Tentative (draft) data provided to the Piedmont Council of Governments by Greensboro Planning Department.

TABLE II-28

POPULATION PROJECTIONS BY SUBBASINS, 1975 TO 2000 WITH CHANGE FROM 1975 TO 2000

	Population Projections						1975 - 2000 Change	
	1975	1980	1985	1990	1995	2000	No.	Percent
Reedy Fork	10,729	17,000	20,150	23,800	24,000	25,000	14,271	133.0
Deep River	596	600	600	600	600	600	4	0.7
Horsepen Creek	8,080	13,500	16,000	17,800	18,000	18,700	10,620	131.4
North Buffalo	85,539	91,300	93,000	97,000	102,000	106,500	20,961	24.5
South Buffalo	67,327	71,100	77,000	83,150	89,250	94,500	27,123	40.4
Reedy Fork (East)	2,857	3,000	3,100	3,200	3,200	3,250	393	13.8
North Buffalo (East)	3,147	6,500	7,500	7,800	8,000	8,150	5,003	158.9
South Buffalo (East)	3,670	8,500	11,000	12,000	12,500	13,000	9,330	254.2
Alamance	13,169	14,500	15,000	15,300	15,400	15,500	2,331	17.7
Buffalo	1,503	1,600	1,700	1,850	1,900	2,000	497	33.1
Totals	196,617	227,600	245,050	262,500	274,850	287,200	90,583	46.1

Source: ER-038


ROCKINGHAM CO
GUILFORD CO
FORSYTH CO
ALAMANCE CO
REEDY FORK
REEDY FORK (EAST)
BUFFALO
NORTH BUFFALO (EAST)
HORSEPEN CREEK
NORTH BUFFALO
SOUTH BUFFALO (EAST)
DEEP RIVER
SOUTH BUFFALO
ALAMANCE
DEEP RIVER
POLECAT CREEK
LAKE BRANDT
HORSEPEN CREEK
NORTH BUFFALO CREEK
SOUTH BUFFALO CREEK
LITTLE ALAMANCE CREEK
BIG ALAMANCE CREEK
PERSONS PER SQUARE MILE
LESS THAN 2000
MORE THAN 2000
MAJOR HIGHWAYS
PLANNING SUBBASIN BOUNDARY
GREENSBORO CITY LIMITS
NORTH
SCALE IN MILES
0
1
2
3

GREENSBORO - GUILFORD COUNTY
REGIONAL WASTEWATER
FACILITIES PLAN

POPULATION DENSITY 2000

ERIC HILL ASSOCIATES
ATLANTA GA

PLANNING CONSULTANTS
WINSTON SALEM N C

capita income, and dwelling units by type (as a percent of the population). Table II-29 shows the age distribution for the Study Area from 1975 to 2000. These figures are based on census data and projections provided by the Greensboro Planning Department for the Study Area. Obvious conclusions from this table are that: (1) persons over 65 will increase and constitute a larger proportion of the population; and (2) the school age population (under 20) will increase, but will constitute a smaller percentage of total population.

TABLE II-29
PROJECTED AGE DISTRIBUTION WITHIN THE STUDY AREA

	1975	1980	1985	1990	1995	2000
0-19	71,481	73,089	74,150	79,758	88,401	92,190
20-39	55,356	72,352	81,445	90,152	88,826	82,246
40-64	53,320	61,435	65,701	65,332	67,096	79,760
65+	16,460	20,724	23,754	27,258	30,527	33,004
TOTALS	196,617	227,600	245,050	262,500	274,850	287,200

Source: ER-038

Per capita income projections were taken from OBERS. These are presented in Table II-30. Between 1975-1980, a 40.4 percent increase is expected; for 1980-1990, a 28.9 percent increase is expected; and for 1990-2000, a 32.4 percent increase is expected.

Useful in the land use projections is a breakdown of population by housing type, calculations of dwelling unit requirements, and acreage required. Table II-31 shows these projections.

TABLE II-30
PROJECTED PER CAPITA INCOME, 1980 - 2000

	Per Capita Income*	Change	
		Number	Percent
1980	$4,780	1,376	40.4
1990	6,166	1,386	28.9
2000	8,165	1,999	32.4

*In 1976 dollars

NOTE: 201 Study Area per capita income assumed same as SMSA.

Source: US-560

Projected employment to the year 2000 is shown in Table II-32. Based on data provided by the Greensboro Planning Department, employment may be expected to increase almost 56 percent, whereas population will only increase approximately 46 percent. Manufacturing and wholesale and retail trade will continue to have the largest percentages of toal employment (50 percent).

Projected per capita earnings by industry type are shown in Table II-33. Services and government are two types of industries which will maintain significant increases to the year 2000. Other industry types will increase, but their percentage increases will level off.

2. Land Use

a. Present General Land Use

Land use for the Study Area was based upon aerial photographs and maps provided by the Environmental Protection Agency. From the data provided, there are seven major land use categories: residential, commercial/services/institutional, industrial (including industrial/commercial complexes and transportation),

TABLE II-31

POPULATION DISTRIBUTION BY HOUSING TYPE AND DWELLING UNIT REQUIREMENTS

		Population Distribution By Housing Type*		Population Change by Type		Dwelling Units Required by Type		Acreage	
	Population	Single-Family	Multi-Family	Single-Family	Multi-Family	Single-Family**	Multi-Family**	Single-Family***	Multi-Family****
1975	196,617	152,378	44,239	--	--	--	--	--	--
1980	227,600	171,223	56,377	18,845	12,138	6,282	6,069	3,141	607
1985	245,050	178,225	66,825	7,002	10,448	2,334	5,224	1,167	522
1990	262,500	188,055	74,445	9,830	7,620	3,277	3,810	1,639	381
1995	274,850	200,366	74,484	12,311	39	3,104	20	2,052	2
2000	287,200	211,092	76,108	10,726	1,624	3,575	812	1,788	81
TOTALS				58,714	31,869	19,572	15,935	9,787	1,593

*Distribution by housing type was determined using calculated percentages for the City of Greensboro of housing types as a percentage of the non-institutional population (See Technical Reference Document-RA-R-406).

**Single-family units are based on 3.0 people per dwelling unit.
Multi-family units are based on 2.0 people per dwelling unit.

***Single-family acreage based on two dwelling units per acre.

****Multi-family acreage based on ten dwelling units per acre.

Source: ER-038

TABLE II-32

EMPLOYMENT PROJECTIONS FOR NON-FARM INDUSTRIES

	1980	1985	1990	1995	2000
Manufacturing	35,493	37,618	38,908	41,271	43,629
Contract Construction	9,511	11,230	12,949	13,145	13,341
Transportation, Communication, and Public Utilities	6,018	6,499	7,116	7,781	8,444
Wholesale and Retail Trade	29,908	31,330	36,151	37,286	38,421
Finance, Insurance, and Real Estate	8,195	9,227	9,941	11,028	12,115
Services and Miscellaneous	16,566	18,530	22,487	23,268	24,138
Government	16,394	18,145	21,933	22,863	23,791
Total Non-Farm Employment	122,085	132,579	149,485	156,642	163,879

NOTE: Projections provided in this table are for the Greensboro "701" Study. However, this area closely corresponds to the EIS Study Area, and the figures would be similar.

Source: GR-296

TABLE II-33

PROJECTED PER CAPITA EARNINGS, BY INDUSTRY TYPE, FOR THE STUDY AREA

	Per Capita Earnings in Thousands of 1967 Dollars						1970-1980 Change		1980-1990 Change		1990-2000 Change	
	1970	1980	1985*	1990	1995*	2000	Number	Percent	Number	Percent	Number	Percent
Manufacturing	1.27	1.73	1.94	2.15	2.44	2.74	.46	36.2	.42	24.3	.59	27.4
Contract Construction	.19	.25	.28	.31	.35	.39	.06	31.6	.06	24.0	.08	25.8
Transportation, Communication, and Public Utilities	.21	.31	.36	.41	.48	.54	.10	47.6	.10	32.2	.13	31.7
Wholesale and Retail Trade	.47	.62	.69	.76	.87	.97	.15	31.9	.14	22.6	.21	27.6
Finance, Insurance, and Real Estate	.15	.23	.27	.31	.37	.43	.08	53.3	.08	34.8	.12	38.7
Services and Miscellaneous	.35	.59	.72	.86	1.06	1.26	.24	68.6	.27	45.8	.40	46.5
Government	.25	.37	.44	.51	.62	.72	.12	48.0	.14	27.8	.21	41.2

NOTE: Data for 1985 and 1995 were not provided in the OBERS projections. For these years, intermediate points between 1980, 1990, and 2000 projections were used.

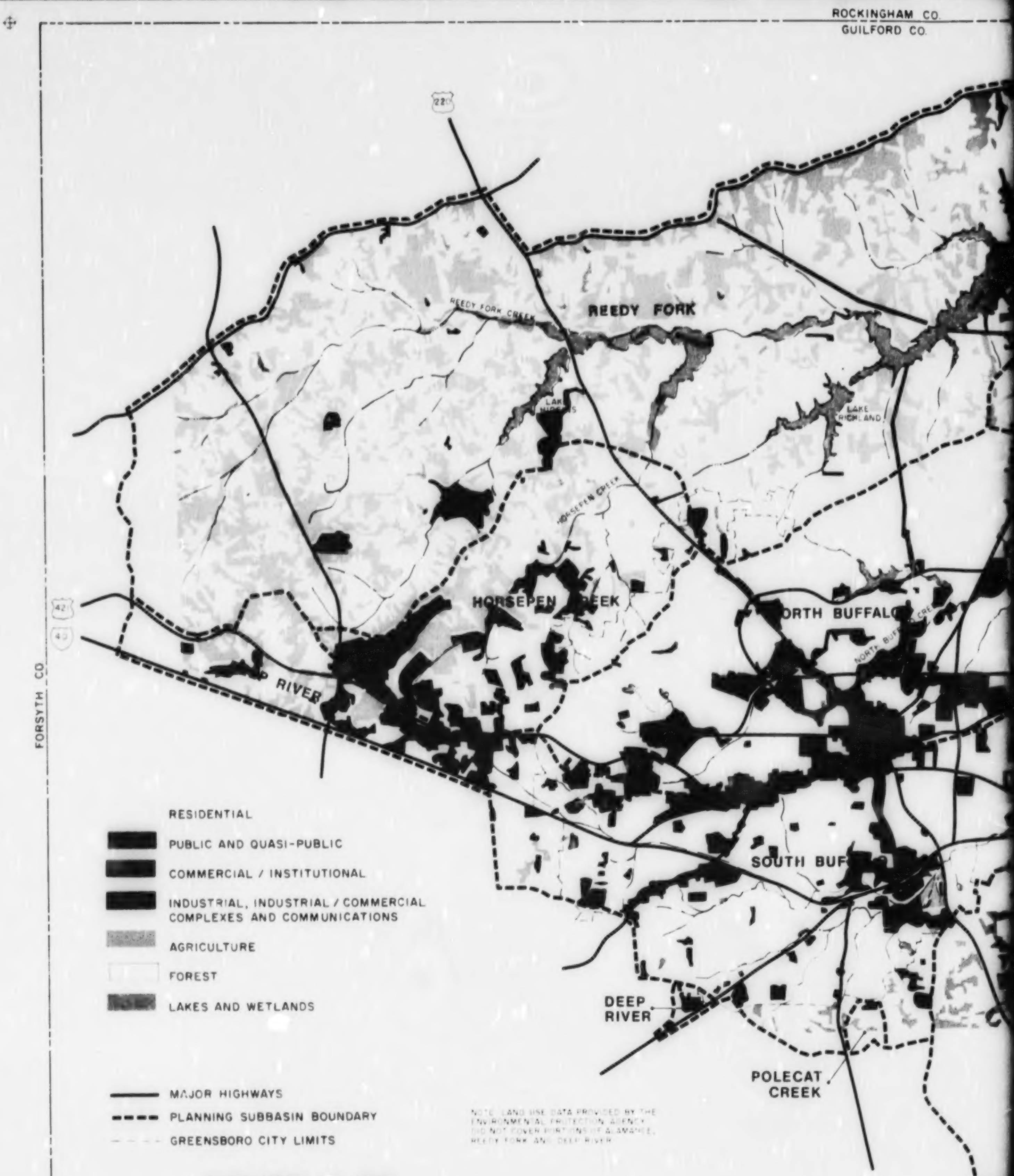
Source: US-560

public and quasi-public areas, agricultural and forest land, water, and extraction areas. Figure II-20 depicts the existing land use for the Study Area by subbasin.

It should be noted that additional areas have been added to the Study Area (namely, Alamance Creek and other minor areas) for which no land use data were available. To determine land use acreage for these areas, land use acreage within the remainder of the subbasin was measured and the proportions of land use were assumed to be the same. Therefore, if the remainder of the subbasin had 52 percent of its land in residential uses, 52 percent of the area with no land use data was assumed to be residential. Table II-34 summarizes current land use acreage for the Study Area by subbasins.

Much economic activity has recently moved north and northwestward, so that the focal point of Greensboro (once the Central Business District) has moved westward. The transportation system has had a major effect on this development. Interstate 40, skirting the southern edge of the city, from east to west, and the Southern Railroad (also east to west), have tended to pull development, particularly that requiring transportation and distribution, linearly along the east-west corridor. U.S. 200, U.S. 29, and U.S. 29A have some development generally in a north-south direction. However, north-south roads provide little connection between major centers (Winston-Salem, Raleigh, and the like), and are, therefore, not as attractive.

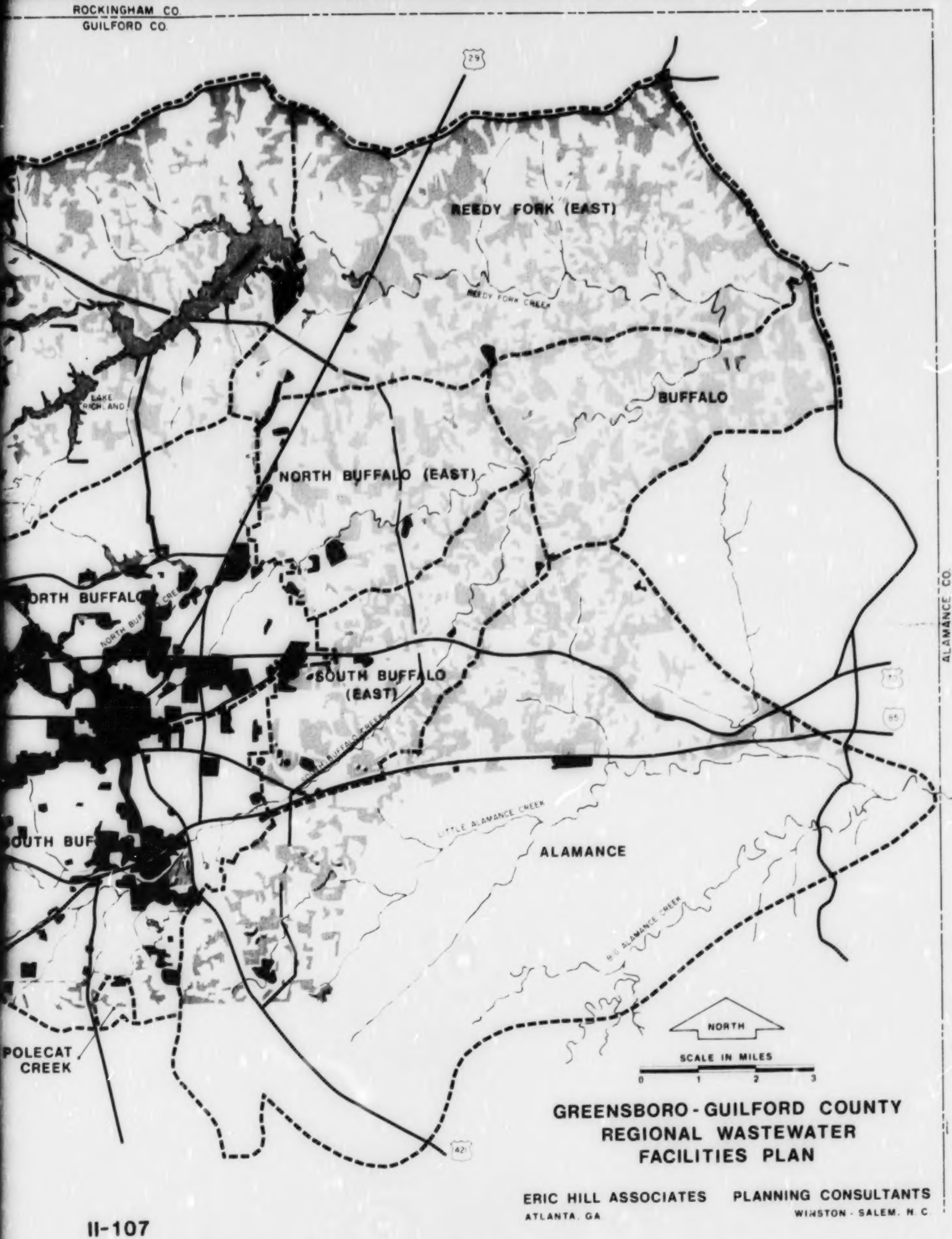
Commercial land use is located in the central area and along major transportation routes. Industrial uses are concentrated near the airport and along Interstate 40, along Market Street, along Interstate 85 to the south, and where rail access is available. For areas outside the city limits, development is stripped along transportation routes. Land use patterns become


ROCKINGHAM CO.
GUILFORD CO.
220
REEDY FORK CREEK
REEDY FORK
LAKE HIGGINS
LAKE RICHLAND
HORSEPEN CREEK
HORSEPEN CREEK
NORTH BUFFALO CREEK
NORTH BUFFALO CREEK
421
40
DEEP RIVER
FORSYTH CO.
SOUTH BUFFALO
DEEP RIVER
POLECAT CREEK
RESIDENTIAL
PUBLIC AND QUASI-PUBLIC
COMMERCIAL / INSTITUTIONAL
INDUSTRIAL, INDUSTRIAL / COMMERCIAL COMPLEXES AND COMMUNICATIONS
AGRICULTURE
FOREST
LAKES AND WETLANDS
MAJOR HIGHWAYS
PLANNING SUBBASIN BOUNDARY
GREENSBORO CITY LIMITS

NOTE: LAND USE DATA PROVIDED BY THE ENVIRONMENTAL PROTECTION AGENCY DID NOT COVER PORTIONS OF ALAMANCE, REEDY FORK AND DEEP RIVER.

FIGURE II-20

EXISTING LAND USE


ROCKINGHAM CO.
GUILFORD CO.
29
REEDY FORK (EAST)
REEDY FORK CREEK
LAKE RICHLAND
BUFFALO
NORTH BUFFALO (EAST)
ORTH BUFFALO
NORTH BUFFALO CREEK
SOUTH BUFFALO (EAST)
SOUTH BUFFALO CREEK
70
85
ALAMANCE CO.
LITTLE ALAMANCE CREEK
ALAMANCE
BIG ALAMANCE CREEK
OUTH BUF
POLECAT CREEK
421
NORTH
SCALE IN MILES
0
1
2
3

GREENSBORO - GUILFORD COUNTY
REGIONAL WASTEWATER
FACILITIES PLAN

ERIC HILL ASSOCIATES
ATLANTA, GA

PLANNING CONSULTANTS
WINSTON - SALEM, N.C.

TABLE II-34

EXISTING LAND USE ACREAGE BY SUBBASIN

		Residential	Commercial	Industrial	Transportation & Communication	Recreation	Agriculture	Water	Extraction	Forest	Total
Reedy Fork	Inside City	26	6	--	--	109	--	19	--	557	717
	Outside City*	4,024	106	27	346	1,023	14,405	3,387	--	28,762	52,179
Deep River	Inside City	19	--	--	--	--	--	--	--	--	19
	Outside City*	316	157	630	73	331	1,194	--	--	1,574	4,275
Horsepen Creek	Inside City	640	109	--	--	51	--	6	--	532	1,338
	Outside City*	1,728	128	448	762	1,030	1,932	32	13	3,610	9,683
North Buffalo	Inside City	11,789	2,560	993	736	979	51	154	--	3,030	20,262
	Outside City*	26	--	--	19	6	13	--	--	77	141
South Buffalo	Inside City	9,498	1,805	1,139	640	384	134	51	--	2,381	16,032
	Outside City*	1,197	69	144	103	137	309	6	--	1,741	3,706
Reedy Fork (East)	Outside City	653	83	77	237	26	8,435	128	--	12,172	21,811
North Buffalo (East)	Outside City	781	96	--	154	160	2,393	70	--	4,916	8,570
South Buffalo (East)	Outside City	960	45	90	154	58	2,752	38	--	3,538	7,635
Alamance*	Outside City	5,834	86	206	1,493	35	15,272	292	172	21,397	44,787
Buffalo	Outside City	173	13	6	--	--	4,493	38	--	4,263	8,986
	Totals	37,664	5,263	3,740	4,717	4,329	51,482	4,221	185	88,540	200,141

*For portions of these subbasins, no land use was provided. Therefore, it was assumed that these areas would have similar characteristics as the remainder of the subbasin. Therefore, total acres with no land use were prorated to each appropriate category.

Source: US-561

rural with agricultural and forest land predominant. Population densities are relatively low.

Land use planning within the county is administered and/or coordinated by three public bodies; the Greensboro Planning Department, the Guilford County Planning Board, and the Piedmont Triad Council of Governments. The current land use plans of both the city and county are outdated and do not adequately meet the land use planning needs of the region. Revisions are now underway and are expected to be complete in the summer of 1977.

Both the city and county have zoning ordinances. In addition, the city has subdivision regulations. The county has issued its "Land Use Goals and Policies" (July, 1976) which contains several important goals or policies around which its land use plan will be developed. These goals and policies are listed in Table II-35.

b. Future General Land Use

General land use for the EIS Study Area for the year 2000 is shown in Figure II-21. Land use was determined using (1) population, dwelling unit, and needed residential acreage projections; (2) existing land use patterns and trends; (3) zoning, and (4) land use goals and policies for Guilford County. Three assumptions were made. First, future land uses will not be developed on environmentally sensitive land (Section II.A.1.h). Environmentally sensitive lands were defined as lands having at least one of the following characteristics: slopes exceeding 15 percent, erosive soils, floodplain or wetlands, areas with existing and proposed noise problems from airport, reservoir buffer zones, sanitary landfill areas, and quarries. Second, the ratio of developed acreage for commercial, industrial, and recreational land uses to current developed land will continue

TABLE II-35

GUILFORD COUNTY LAND USE GOALS AND POLICIES

GOALS:

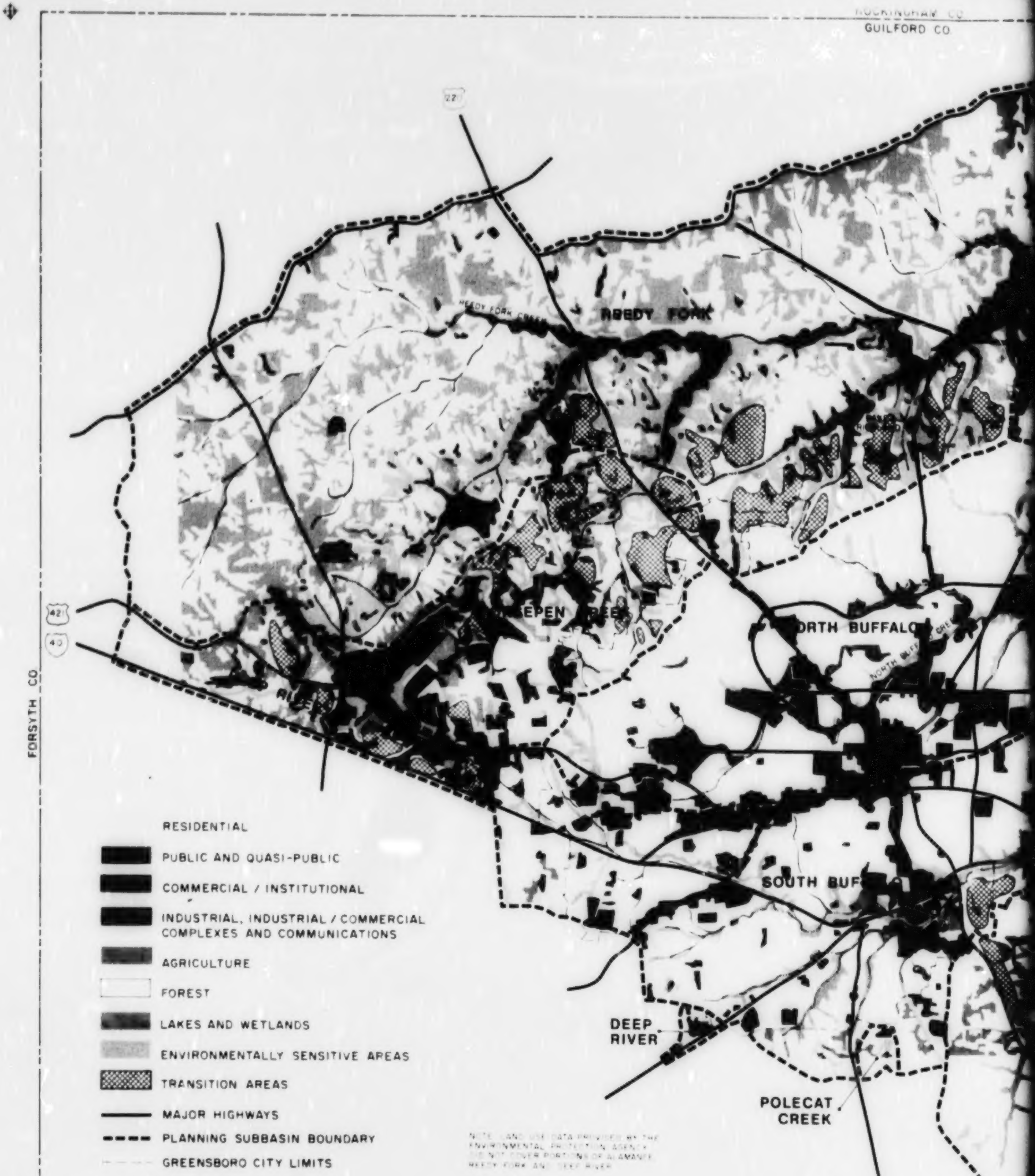
1. Growth should be encouraged in areas of the county which are better equipped to accommodate it.
2. Proper land use planning should increase the social and economic opportunities for all citizens.
3. Development should increase the individual's opportunities and foster a sense of community.
4. Coordinate community facilities and services with other development.
5. Encourage the location of low water-consuming industries in Guilford County.
6. Preserve and protect water quality and quantity.
7. Ensure the future provisions of adequate water and sewer services to county citizens.
8. Promote a balanced, safe, efficient, and environmentally sound transportation system throughout the county.
9. Identify Guilford County's natural and environmentally critical areas that must be preserved and protected.
10. Protect historic buildings and sites.
11. Utilize floodplains to protect the health, safety, and personal property of citizens.
12. Acquire and protect selected open space areas in the county.
13. Incorporate environmental protection into all public and private plans, especially in municipal watersheds.

POLICIES:

1. Problems of residential development are complicated by a limited water supply, poor soil types, and other environmental considerations that are a natural deterrent to the development of much of the county. There is a need to assign priorities to potential growth areas and then to provide public utilities accordingly. The interlocking relationship of commercial and residential development must be incorporated into flexible and innovative design approaches applied through our land use controls.
2. Since the provision of roads, water, and sewer stimulate growth, future placement of these items must be carefully analyzed. The public provision of facilities and services should balance such considerations as the solution of existing problems, the encouragement of new growth, and the planning of future needs. Too often the construction of community facilities creates a demand far in excess of what was planned.
3. The physical characteristics of land must serve as one of the basic guidelines for determining the location and density of development. Water quantity and quality have been identified as the county's two major problems. Areas designated for water impoundment for public use have been the areas most susceptible to new growth and development over the years. If development is to continue to occur in these areas, efforts must be made to minimize those factors which could affect the quality and quantity of our water supply.

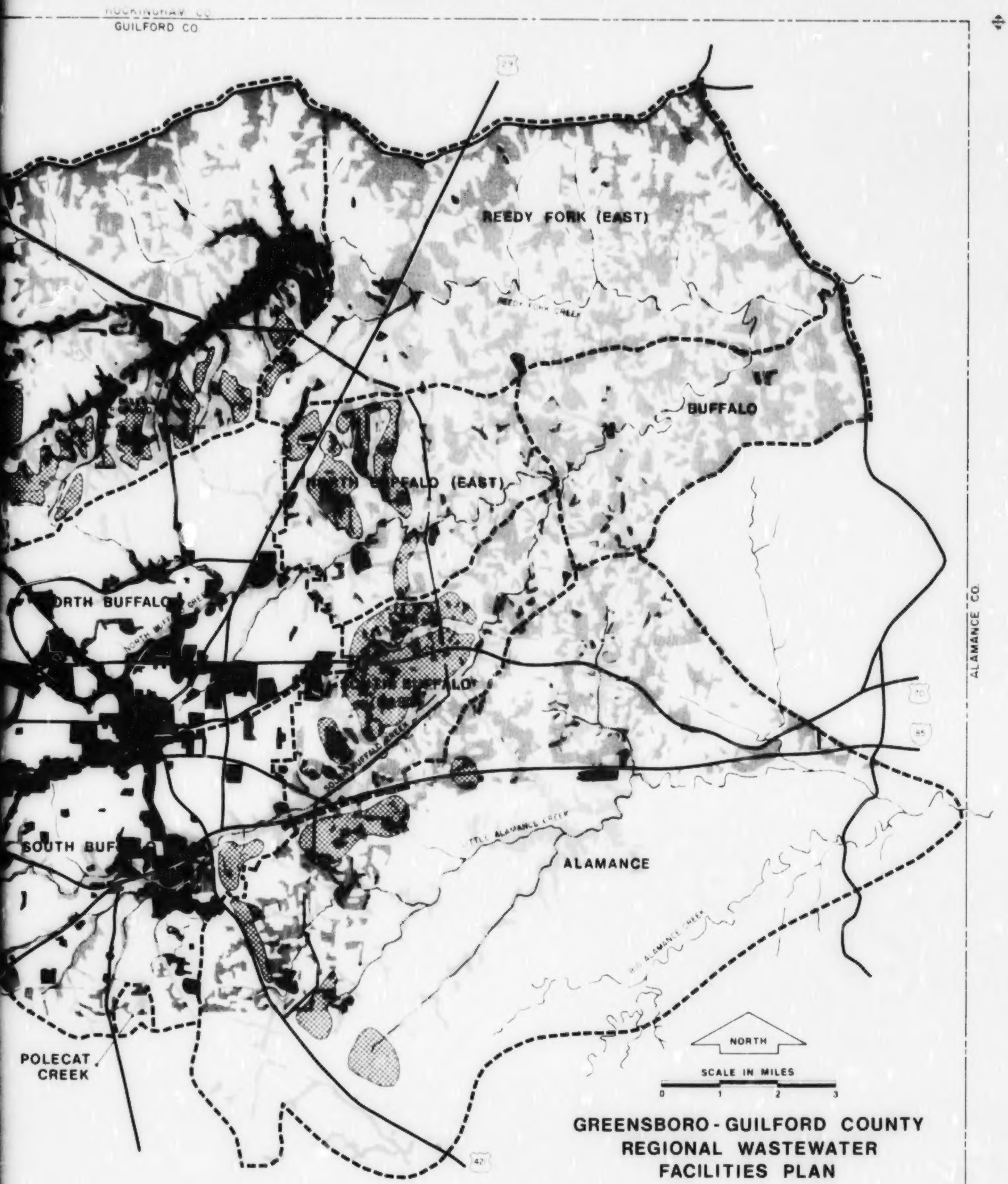
In addition to these goals and policies, the city has provided to the COG a map showing tentative urbanization to the year 2000 given an additional sewage treatment plant. This description of growth and conversations with the Planning Department were relied on heavily in planning for future land uses.

Source: LA-262


ROCKINGHAM CO
GUILFORD CO
FORSYTH CO
221
421
40
REEDY FORK CREEK
REEDY FORK
SEPEN CREEK
NORTH BUFFALO
NORTH BUFFALO CREEK
SOUTH BUF
DEEP RIVER
POLECAT CREEK
RESIDENTIAL
PUBLIC AND QUASI-PUBLIC
COMMERCIAL / INSTITUTIONAL
INDUSTRIAL, INDUSTRIAL / COMMERCIAL COMPLEXES AND COMMUNICATIONS
AGRICULTURE
FOREST
LAKES AND WETLANDS
ENVIRONMENTALLY SENSITIVE AREAS
TRANSITION AREAS
MAJOR HIGHWAYS
PLANNING SUBBASIN BOUNDARY
GREENSBORO CITY LIMITS

NOTE: LAND USE DATA PROVIDED BY THE ENVIRONMENTAL PROTECTION AGENCY DID NOT COVER PORTIONS OF ALAMANCE, REEDY FORK AND DEEP RIVER

FIGURE II-21
FUTURE LAND USE


ROCKINGHAM CO.
GUILFORD CO.
29
REEDY FORK (EAST)
REEDY FORK CREEK
BUFFALO
NORTH BUFFALO (EAST)
NORTH BUFFALO
NORTH BUFFALO CREEK
SOUTH BUFFALO CREEK
ALAMANCE CO.
70
85
LITTLE ALAMANCE CREEK
ALAMANCE
BIG ALAMANCE CREEK
POLECAT CREEK
NORTH
SCALE IN MILES
0
1
2
3
421

GREENSBORO - GUILFORD COUNTY
REGIONAL WASTEWATER
FACILITIES PLAN

ERIC HILL ASSOCIATES
ATLANTA, GA

PLANNING CONSULTANTS
WINSTON SALEM, N. C.

in the year 2000 (residential - 73 percent; commercial - 10.5 percent; industrial - 8 percent; recreational - 8.5 percent). Table II-36 shows the net developable land within each of the planning subbasins. The county and city are presently revising their land use plans to be completed during the summer of 1977. However, a great deal of data has already been developed and is incorporated herein. Efforts have been made to coordinate the recommendations in the EIS with the city and county. Third, future development is expected first on vacant lands within the city or where public services are available, and generally along major traffic arteries.

Table II-37 shows the additional proposed acres and Figure II-21 shows the transition areas that are proposed to absorb the majority of future development. Both Figure II-21 and Table II-37 are based on the assumption that sewer service will be provided east of the city limits, opening this land for development.

The trend in growth has been to the north and west of the city. One factor that has contributed to the direction of this growth is soil types. Septic tanks are perceived to be more suitable for lands in the north and west than east and southeast, although this difference is a matter of degree.

Though trends will still exert considerable pressures for growth to the west, over 60 percent of the existing vacant land suitable for development and lying within five miles of the Central Business District is located in the southeast quadrant. This land is now well serviced by major streets including I-85, U.S. 70, U.S. 200, and U.S. 421. With the continued increase in fuel costs, people may choose to locate closer to their places of employment. The city's policies and programs to upgrade housing and other conditions in the low-income areas, and a lessening of the stigma attached to black-occupied areas, may make this

TABLE II-36

DEVELOPED, VACANT, ENVIRONMENTALLY SENSITIVE LAND, AND NET DEVELOPABLE LAND WITHIN THE STUDY AREA

		Developed		Vacant		Environmentally Sensitive Land **		Net Developable Land	
	Acreage	Within City	Outside City	Within City*	Outside City	Within City**	Outside City	Within City	Outside City
Reedy Fork	52,896	141	5,526	706	43,266	78	10,458***	628	32,808
Deep River	4,294	19	1,507		2,768	--	1,159		1,609
Horsepen Creek	11,021	800	4,096	674	5,555	69	3,053	605	2,502
North Buffalo	20,403	17,037	51	3,892	90	779	13	3,113	77
South Buffalo	19,738	13,466	1,650	3,188	2,056	934	435	2,254	1,621
Reedy Fork (East)	21,811	--	1,076	--	20,735	--	627	--	20,108
North Buffalo (East)	8,570	--	1,191	--	7,379	--	1,229	--	6,150
South Buffalo (East)	7,635	--	1,307	--	6,328	--	1,549	--	4,779
Alamance	44,787	--	7,946	--	36,841	--	3,367***	--	33,474
Buffalo	8,986	--	192	--	8,756	--	653	--	8,103
Total	200,141	31,463	24,542	8,460	133,774	1,860	22,543	6,600	111,231

*Vacant land within the city was taken from the Environmental Assessment (HA-544) as prepared by the Greensboro Planning Department.

**Environmentally sensitive land is based on data developed by the Greensboro Planning Department.

***A map showing the total environmentally sensitive lands within these areas was not available.

Source: US-561
GR-295

TABLE II-37
PROPOSED ADDITIONAL ACRES BY LAND USE AND PLANNING SUBBASIN

Subbasin	Residential	Commercial	Industrial	Parks
Reedy Fork	1,937	280	200	200
Deep River	0	50	250	0
Horsepen Creek	1,440	210	150	150
North Buffalo	2,846	400	250	300
South Buffalo	3,690	530	300	400
Reedy Fork (East)	53	0	0	100
North Buffalo (East)	680	95	75	100
South Buffalo (East)	1,268	185	125	150
Alamance	316	50	50	50
Buffalo	70	0	0	0

Source: ER-038

close-in vacant land in the southeast quadrant more attractive to developers in the future. Attraction to this area should be particularly true if adequate sanitary sewer service becomes available. Therefore, a greater percentage of potential growth has been assigned to these areas than a straight projection of past trends would indicate.

For Buffalo and Reedy Fork (East), little additional growth is shown because of the distance from the central city, public services, and employment centers. The Deep River subbasin has no residential growth; however, this subbasin will absorb additional commercial and industrial growth because of its location near the airport, I-85, and the Southern Railway.

The additional acres needed for various land uses are directly related to projected population. Residential land use will continue to increase within the city and spread to outlying areas. Some redevelopment will occur with lower density uses intensifying.

Commercial uses will intensify in the core area and along major transportation arteries. Scattered neighborhood commercial uses will be provided conveniently to their customers.

Industrial uses will intensify in the Deep River, South Buffalo, Reedy Fork, Horsepen Creek, and North Buffalo basins. Industrial parks should be encouraged. Around the airport, industrial uses should increase. Since a large portion of this area is subjected to noise not conducive to residential habitation, commercial and industrial uses are best suited to this area. In the southern part of the Study Area, industries should also begin to locate. Large tracts of land are presently zoned for industrial uses.

3. Community Services and Facilities

a. Police

At present, the Greensboro Police Department has 366 sworn personnel which gives a ratio of officers to population of 2.5 per 1,000. There are 76 civilian personnel in the department.

The county also provides law enforcement officers. The 1975-1976 budget authorized 214 full-time positions in the county's law enforcement system which serves the unincorporated areas of Guilfore County. This gives a ratio of officers to population of .72 per 1,000.

b. Fire Protection

The City of Greensboro's fire department in 1972 had five truck companies and 11 engine companies housed in ten fire stations. Since 1972, Greensboro has built additional fire stations and is planning to continue to expand service. Currently, the department has a total manpower of 283 personnel, of which 263 are permanently assigned to firefighting, 12 are assigned to fire prevention, five are assigned to administration, and three are assigned to fire training. Therefore, there are roughly 1.8 firefighting personnel per 1,000 residents.

The Greensboro Fire Department had a Class III rating as determined by the American Insurance Association.

Guilford County employs a Fire Marshall who is charged by County Ordinances and North Carolina General Statutes with providing fire protection services, including fire prevention, fire investigation, and firefighting. In addition, the Fire Marshall coordinates the activities of all rural volunteer fire departments in the county. There are over 1,000 volunteer firefighters, and the county employs 33 people full-time for the county fire department.

c. Solid Waste Disposal

Refuse collection and disposal is administered in the city by the Sanitation Division of the Department of Public Works. The Sanitation Division employs 120 people, of which 14 are temporary employees. Disposal of municipal wastewater treatment residuals is discussed in Section II.B.8.b. and will not be addressed in this section.

In addition to refuse collection and disposal, the division also has the responsibility of sweeping streets and removing leaves during the "leaf season." There are 32 additional employees involved in street cleaning, waste disposal, and other kinds of sanitation jobs.

As described in the Environmental Assessment (HA-544), the city currently provides collection services to all property except industrial establishments. In residential areas, the curb collection method is used, and garbage is collected two days each week. The city does not provide services for the disposal of industrial solid waste or pretreatment sludges. These wastes are processed for ultimate disposal with private industrial facilities.

In commercial areas, trash is also collected each week, except in the downtown area where daily collections are made. Industrial trash is not collected by the city. Industrial firms must either haul their own waste or contract a private firm to do so. The city does, however, allow these firms to use the city landfill at White Street. Costs of collection and disposal of wastes are paid from ad valorem taxes (for residential and commercial customers) and landfill operating revenues collected from private contractors who utilize the landfill for disposal.

In addition to the normal collection system, the Sanitation Division also operates a newspaper recycling program. These papers are collected by sanitation forces three times per week and hauled to a local waste paper dealer who shreds and bales the paper. The shredded paper is then shipped to various plants for recycling.

The city has used the sanitary landfill method of disposal for many years. Prior to using the landfill method exclusively, the city operated an incinerator. The incinerator was discontinued in 1958. The present method of disposal involves burying waste under a layer of soil and then compacting it to avoid erosion and uneven settling of the land. There have been no instances of significant adverse environmental effects as a result of this operation. For example, Keeley Park, a City of

Greensboro public park, will be enlarged as land is reclaimed from the existing landfill. The major disadvantage to this method is obtaining new landfill sites in suitable locations. At present utilization rates, the site should be adequate in area for about 12 more years. However, the location of this site is not favorable to trucks making rounds in the south and west since they must travel several miles in order to deposit waste items.

In 1970, the city purchased a trash compactor which reduces the volume of trash before it is buried. This device compacts waste by 50,000 pounds of pressure and minimizes the area waste occupies. This compactor has a capacity of 80 tons per hour.

Collection of solid wastes in unincorporated areas outside the city is by private collectors, with the wastes hauled to either the Greensboro or High Point landfills. A 1974 study of solid waste disposal for Guilford County recommended coordinated countywide service. This recommendation has not been implemented and collection by private contractors continues. The cities of Greensboro and High Point are paid for use of their landfills by private contractors on a load (volume) basis.

The city is presently involved in a joint venture with the governments of High Point and Guilford County in obtaining new landfill sites. This project involves three sites, and each will have a trash pulverizer that shreds waste before it is buried in an adjacent sanitary landfill. The sites will be installed in phases. The first site is adjacent to the existing landfill in High Point and covers approximately 100 acres, including the landfill. The High Point site has been operational, including the pulverizer, since January of 1973. The second site will be located in western Guilford County in the vicinity of the airport. The third site will be adjacent to the existing Greensboro landfill off of White Street. The second (airport) site is not yet operational. Any government, private collector, individual, or industry that supplies its own trucks may use the site of its choice. There are also plans to sell any scrap or pulverized materials to those dealing in reusable materials. Possibly some of the operating expenses of the collection and disposal functions could be realized from the sale of this material.

Looking to the future, Greensboro, High Point, and Guilford County, together with the City of Winston-Salem, are investigating the possibility of rail haul of solid wastes from these areas to Duke Power Company's Belews Creek steam power plant about 20 miles northwest of the Study Area for incineration in the steam boilers there. If this possibility fails to materialize, additional landfill sites will probably have to be developed before the end of the study period, one of which may be the site currently proposed near the airport.

d. Schools

Guilford County has three public school administrative units although county funds finance all buildings and grounds used for public education in Guilford County, including Greensboro and High Point. The three administrative units are the Guilford County Board of Education, the Greensboro City Board of Education, and the High Point City Board of Education.

The Greensboro School District's boundaries are not coterminous with the corporate limits; therefore, someone who lives in the city can attend county schools, and some residents outside the city limits can attend city schools. The Greensboro school system currently has 40 schools in operation with 1,350 teachers instructing 26,228 pupils--or a favorable student-teacher ratio of 19.4 to 1.

e. Libraries

The Greensboro Public Library provides consolidated library service on a county-wide basis, except for the separately operated libraries in High Point and Gibsonville. Currently, the main library has a staff of 31 people and in 1971 had a collection of 267,227 volumes. The Southeast Branch has three staff members and in 1971 had a collection of 18,840 volumes. The Benjamin Branch has four staff members and 21,000 volumes. The Southwest Branch has four employees and the Northeast Branch has four employees. Total libray employment is 46 people. Quaker Village and Pomona Community branches are not staffed at present.

f. Health

Guilford County provides health services to county residents. The Public Health Department provides the following services: health education, environmental health, nursing, dentistry, clinical, oaboratory, nutrition, physical therapy, speech and hearing, social services, and administration. The department has a staff of approximately 310 people.

The county also provides for an Area Mental Health Program. This service includes programs for the prevention and treatment of psychiatric illnesses, mental retardation, alcoholism, and drug abuse. Presently, there are about 216 full-time employees of the Mental Health Program.

There are three hospitals in Greensboro with a total of 837 beds. For the 230,000 people in the Greater Greensboro Area (excluding High Point) this total gives a ratio of 3.6 beds per 1,000 people. However, beds per 1,000 population is not a reliable method for evaluating hospital effectiveness. More importantly, no emergency or urgent case waits for admission at any of the three hospitals. At Wesley Long and Cone hospitals elective surgery normally requires a 24-hour waiting period, while Richardson Hospital has never had a waiting period. In conclusion, Greensboro is adequately equipped and is making efficeint use of its facilities to provide superior health care to all in need of it.

g. Welfare

The county's Department of Social Services performs six functions: (1) services to families and children; (2) services to adults; (3) supportive services; (4) financial and medical assistance to categorically eligible persons as defined by law; (5) general or emergency financial assistance; and (6) special projects which are conducted within the department through grants from federal or other financial resources. The Department presently employs 436 people to serve Guilford County.

h. Administrative Facilities

The Governmental Center in Greensboro houses offices of both the City of Greensboro and Guilford County. The center was completed in 1972 and provides ample office space.

4. Taxes and Budgeting

The average city and county tax rate in 1976 was $1.695 per $100 assessed valuation. If property is within the city limits, the city taxes are $.88 per $100 assessed valuation. For rural property, the tax rate is $.74 per $100 assessed valuation. For the city in FY 75-76, $.77 of the total tax rate ($.88) went for General Fund expenditures. In FY 76-77, $.78 of the total is going for General Fund expenditures.

For FY 1975-76, Table II-38 was prepared to show the per capita expenditures for major community services and facilities. Monies for capital improvements and breakdowns of appropriations and expenditures for selected community facilities and services for both the city and county are found in the Technical Reference Document (RA-R-406).

TABLE II-38
1975-76 PER CAPITA EXPENDITURES FOR SELECTED COMMUNITY SERVICES AND FACILITIES, GREENSBORO AND GUILFORD COUNTY

	Per Capita Expenditures		
Community Services and Facilities	Greensboro	Guilford	Total
Transportation:			
Powell Bill Funds (state)	$10.33	--	$10.33
Streets, Sidewalks, Maintenance	14.78	--	14.78
Total Transportation	$25.11		$25.11
Water and Sewer:	$38.95	$ 3.71	$42.66
Public Safety:			
Administration*	$ .48	$15.40	$15.88
Law Enforcement	34.50	27.69	62.19
Fire	20.03	10.33	30.36
Total Public Safety	$55.01	$53.42	$108.43
Health and Welfare:	--	$106.78	$106.78
Public Works:	$21.63	$ 1.92	$ 23.55
Parks and Recreation:	$23.46	$ .43	$ 23.89
Schools and Libraries	$ 5.82	$ 76.64	$ 82.46

*For City, includes civil defense.

Source: GR-297

5. Archaeological, Cultural, Historical, and Recreational Resources

a. Archaeology

The Piedmont area of North Carolina was inhabited by Indians for at least ten thousand years before present and probably for a longer period than that (CL-093). The Indians of the area were the Siuan linguistic division and the tribes in the area were the Saura, the Ocaneechi, the Sissipahaw, and the Kegauwee. The Tuscarora Indians of the Iroquoian linguistic division were known to be east of the Piedmont but they cannot be placed in the Guilford County area (CL-093). Since it is known that Indians were pre-Columbian inhabitants to the Piedmont, it is logical to expect archaeological artifacts to be present in Guilford County.

The National Register does not list any archaeological sites in Guilford County. However, archaeological research has been conducted in the Piedmont by Joffre Coe and specifically in Guilford County by the Museum of Man at Wake Forest University. Once the Wake Forest research is available, a discussion of Guilford County's archaeological resources will be possible. It should be noted that known sites are often not revealed to the public out of fear of pilferage by amateurs. Also, the North Carolina Department of Cultural Resources will evaluate the ultimate wastewater treatment system to insure that archaeological resources are preserved.

b. Historical Resources

1. Historical Perspective

The coastal areas of North Carolina were visited by non-English speaking explorers throughout the 16th century. However, it was 1584 before English explorers dispatched by Walter Raleigh saw the area. An early coastal trade existed between the English and the native Indians, but it was 1653 before a permanent English settlement was established at the west end of Albermarle Sound. In general, the early English settlers stayed on the Coastal Plain where they had access to ocean shipping and where the plantation system of agriculture could be utilized.

The Piedmont physiographic region to the west of the Coastal Plain did not lend itself to plantation agriculture and was not settled as an extension of the eastern Carolina coastal settlements. Rather, most migrants entered the Carolina Piedmont via the Shenandoah Valley from Pennsylvania. The Guilford County area was settled predominantly by Scotch-Irish and German peoples, although some people of English ancestory also settled in the area. Since the Piedmont area was not suitable for the plantation system, Negro slaves were not utilized on a wide scale in the early settlement.

Guilford County was actually created from the reorganization of Orange and Rowan Counties in 1771. When it was created, Guilford County was three times its current size. However, in 1779 Randolf County to the south was created and in 1785 Rockingham County to the north was created. The county seat of Guilford County was established in 1808 in "Greensborough," named for General Nathaniel Greene of Revolutionary War fame.

From 1808 until the Civil War, Greensboro was a rather sleepy community with respect to growth. However, in 1858 an east-west railroad from Morehead City to Morgantown, which passed through the city, made Greensboro more attractive for development. Between 1884 and 1904 the industrial base of Greensboro was established with textiles, clay products, furniture, and other wooden products leading the way (LI-176).

2. Historic Sites in the Study Area

Currently there are two National Register sites, Blandwood and the Jefferson Standard Building, in the Study Area (Figure II-22). Figures in the Technical Reference Document (RA-R-406) show the distribution of other historic sites, including structures of architectural importance, in the Greensboro/Guilford County area (excluding High Point and Jamestown).

Blandwood was built in the 1840's for Governor John H. Morehead. It was designed by Alexander Jackson Davis as an example of Italiante Revival architecture. The Jefferson Standard Building was designed by Charles Hartman and built in 1922-23. It is probably Greensboro's most prominant landmark being 17 stories high and opulently ornamented.

Guilford Courthouse National Military Park is located just east of Highway 220 northwest of Greensboro (Figure II-22). The Battle of Guilford Courthouse between General Nathanial Green's Continental regulars and British forces under Lord Charles Cornwallis was fought at this site on March 15, 1781. This battle proved to be instrumental in the eventual defeat of the British at Yorktown.

At least 24 structures are now under consideration as National Register sites. Also, two areas of Greensboro are being

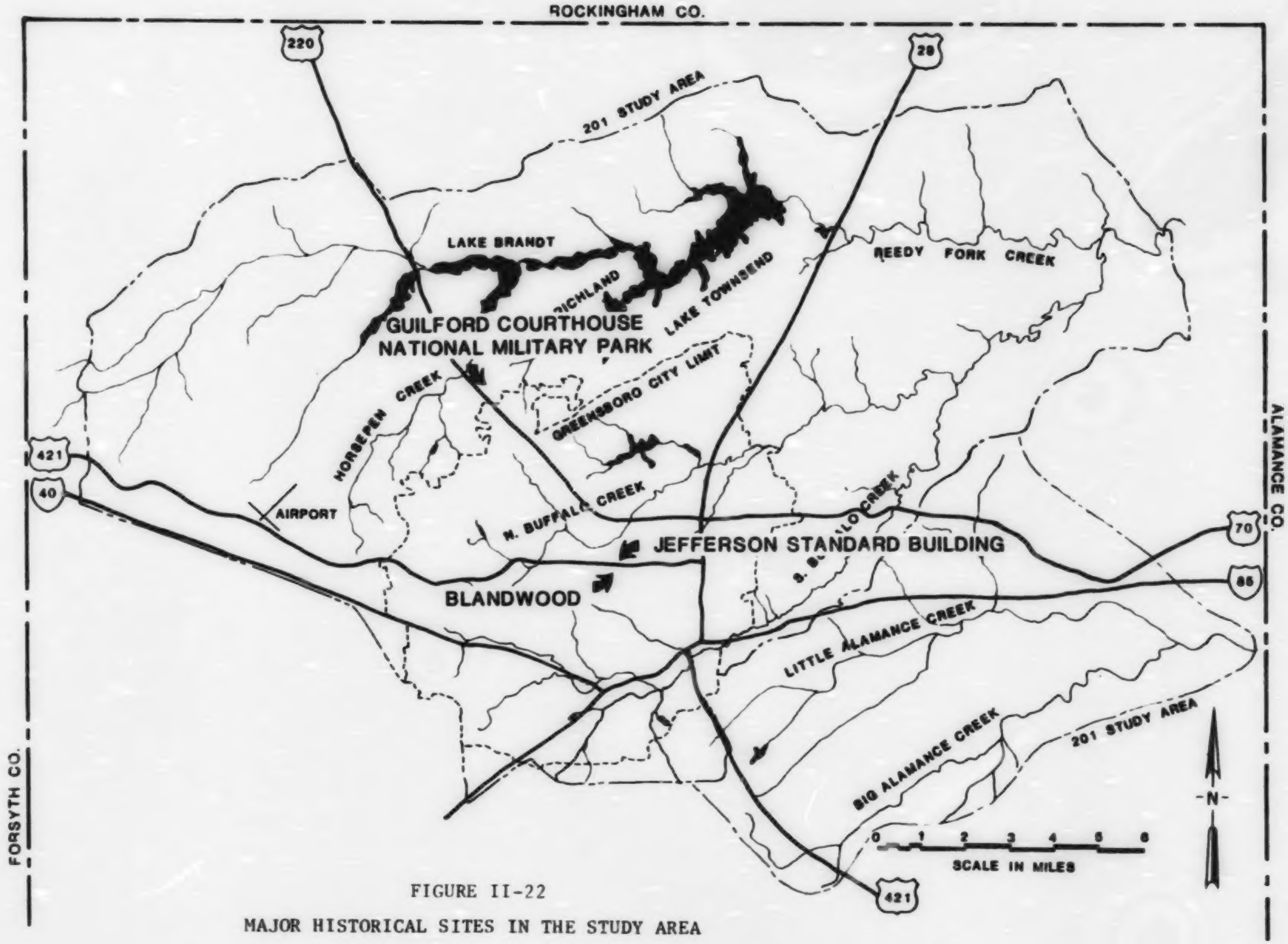

ROCKINGHAM CO.
ALAMANCE CO.
FORSYTH CO.
220
29
421
40
70
85
201 STUDY AREA
LAKE BRANDT
RICHLAND
LAKE TOWNSEND
REEDY FORK CREEK
GUILFORD COURTHOUSE NATIONAL MILITARY PARK
GREENSBORO CITY LIMIT
HORSEPEN CREEK
AIRPORT
N. BUFFALO CREEK
S. BUFFALO CREEK
JEFFERSON STANDARD BUILDING
BLANDWOOD
LITTLE ALAMANCE CREEK
BIG ALAMANCE CREEK
-N-
0 1 2 3 4 5 6
SCALE IN MILES

FIGURE II-22

MAJOR HISTORICAL SITES IN THE STUDY AREA considered for Historic District status, the Southern Railway Complex and the South Elm Street Area.

c. Recreational Facilities

There appears to be a wide variety of recreational activities and facilities to choose from and a fairly uniform spatial distribution. Figures presented in the Technical Reference Document (RA-R-406) show the location and distribution of the various types of facilities presently available in the Greensboro area. According to the City's Capital Improvement Program (GR-263), some major additions to the Parks and Recreation Department facilities are planned for the near future, including a Bikeway Plan, proposed parks, and proposed recreation centers. These are shown in Figure II-23.

6. Transportation

Greensboro's transportation links with North Carolina and the rest of the South are instrumental in understanding the city's growth since World War II. First of all, Greensboro has always had an advantageous position with respect to rail service. It still maintains a model position as a rail center. Greensboro sees more freight trains daily than other major cities such as Raleigh or Charlotte in North Carolina.

The Greensboro-High Point Airport is an important traffic center in the southeastern United States with major airlines such as Piedmont, United, Delta, and Eastern providing regular service. The location of the airport between Greensboro, Winston-Salem, and High Point insures that it serves a much larger trade area than just the city of Greensboro. An expansion of the airport's physical plant is currently underway.

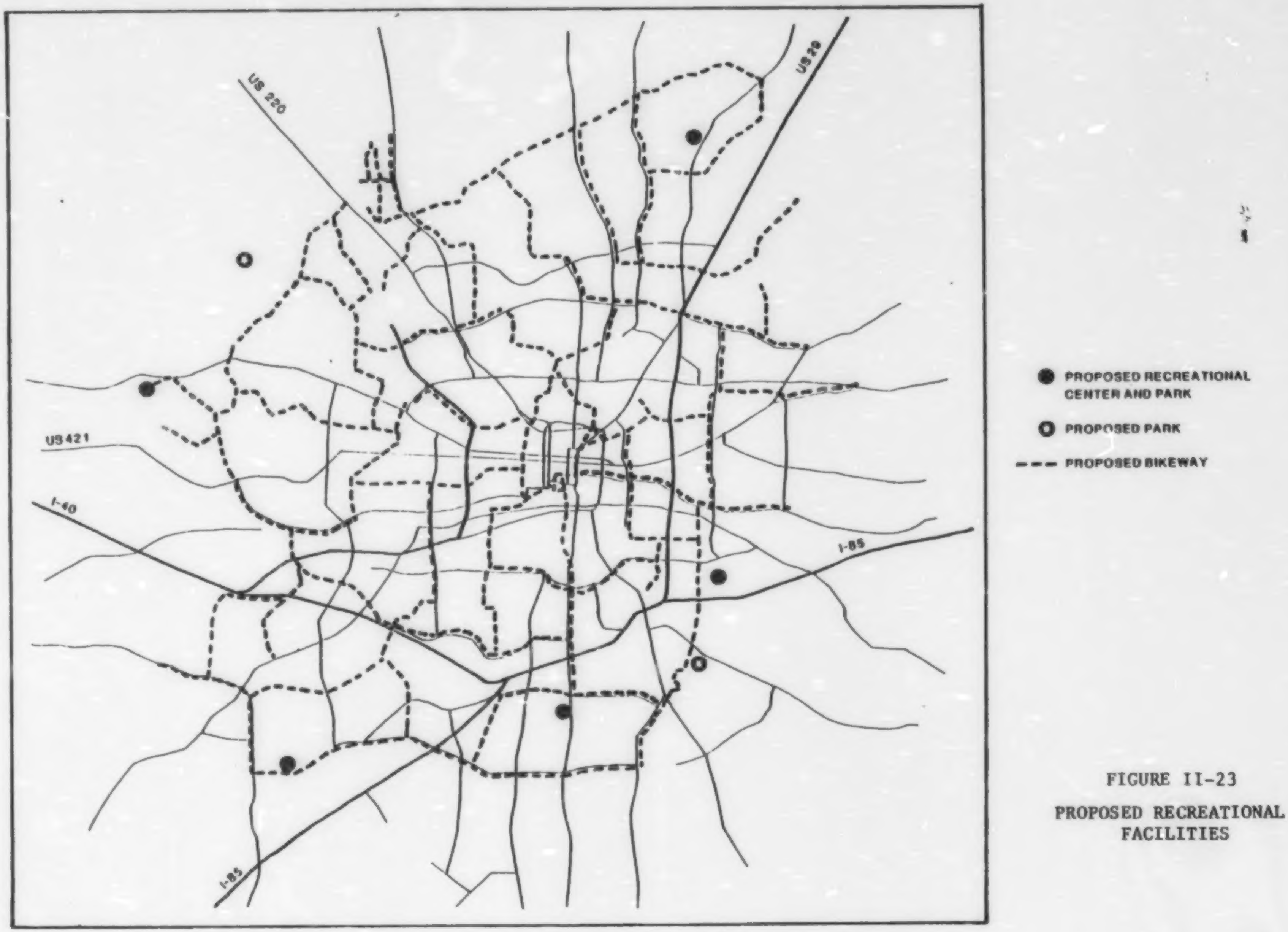

US 220
US 29
US 421
I-40
I-85
I-85
● PROPOSED RECREATIONAL CENTER AND PARK
○ PROPOSED PARK
- - - PROPOSED BIKEWAY

FIGURE II-23
PROPOSED RECREATIONAL FACILITIES

Greensboro's highway links with North Carolina and the South are extremely important in understanding Greensboro's growth in recent years. Interstate 40 provides a link with Winston-Salem, while Interstate 85 connects Greensboro with the Raleigh-Durham area in the east, High Point and Charlotte to the southwest. Greensboro is a focal point for truck traffic in the state. Intrastate bus traffic indicates the same centrality for Greensboro.

With respect to the Greensboro area, the intersection of Interstate 85 and Interstate 40 dominates local traffic counts. Figure II-24 shows the heaviest traffic in the southeast part of town where the highways join (GR-279). The next major thoroughfares are U.S. 29-70 going north and Wendover Avenue going east-west on the north side of the Central Business District. In general, the traffic counts are higher on the west side of the Central Business District as the less important streets showing the daily community flow of people in new suburban areas west of town.

Figure II-25 shows the basic features of the proposed Greensboro thoroughfare plan. The key feature of the plan is the proposed links to existing thoroughfares. The major proposed thoroughfares going toward the Central Business District are from the northwest and southwest, designed to either carry existing traffic to and from those areas or to accommodate anticipated growth in those areas.

7. Resource Use

a. Existing Electricity Use

Duke Power Company is the sole supplier of electricity for the Guilford County area and specifically for the City of

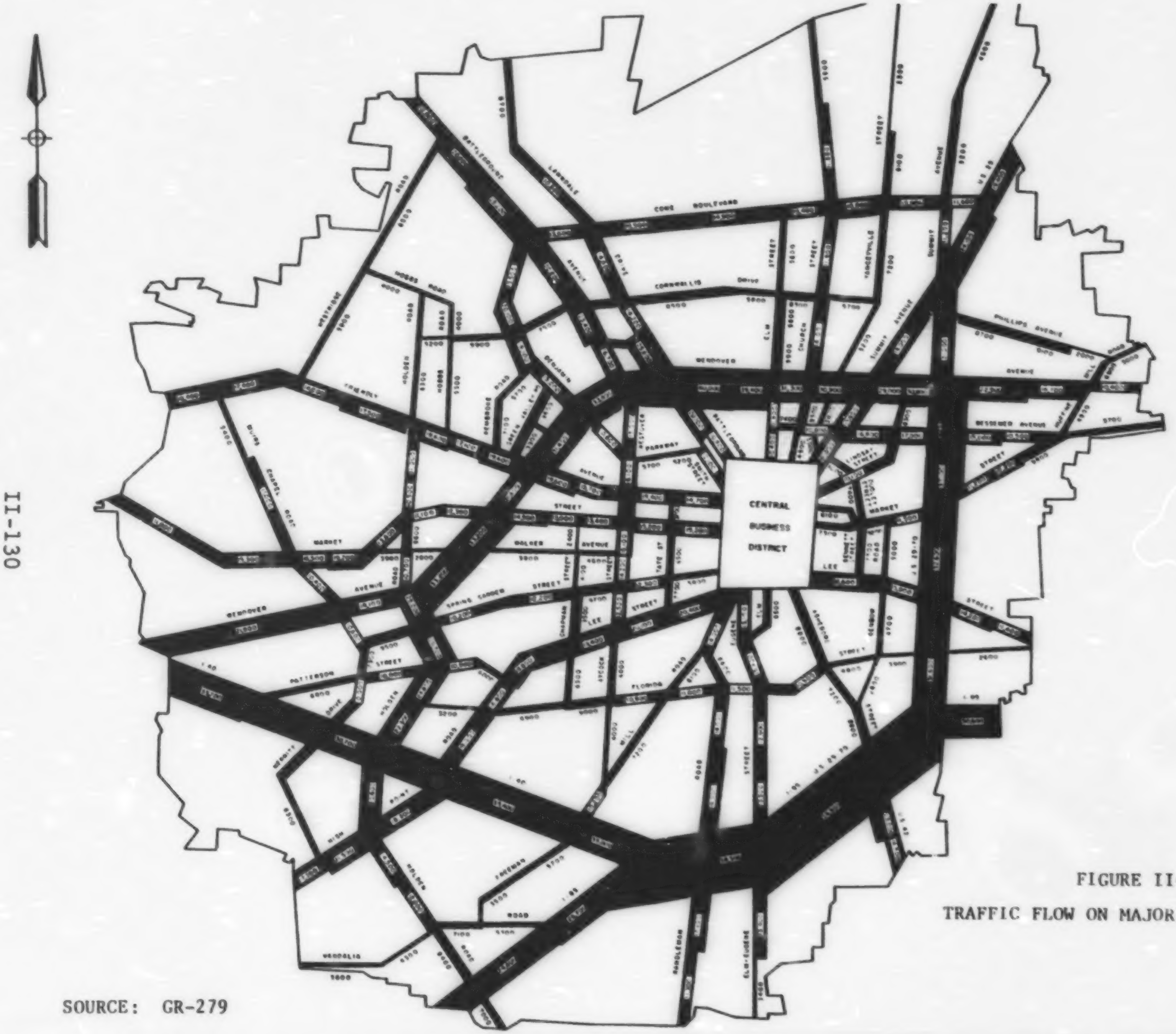

CENTRAL
BUSINESS
DISTRICT
CONE BOULEVARD
BATTLEGROUND
LAWNDALE
CORNWALLIS
DRIVE
WENDOVER
PHILLIPS AVENUE
BESSEMER AVENUE
WESTRIDGE
HOBBS ROAD
HOLDEN
FRIENDLY
MARKET
SPRING GARDEN
PATTERSON
FLORIDA
FREEMAN
RANDLEMAN
ELM-EUGENE
VANDALIA
PARKWAY
TATE ST
LEE
STREET
AVENUE
ELM
CHURCH
SUMMIT
YANCEYVILLE
U.S. 29
I-85
I-40
U.S. 421
U.S. 29 70 I-85

FIGURE II-24

TRAFFIC FLOW ON MAJOR STREETS (1975)

SOURCE: GR-279

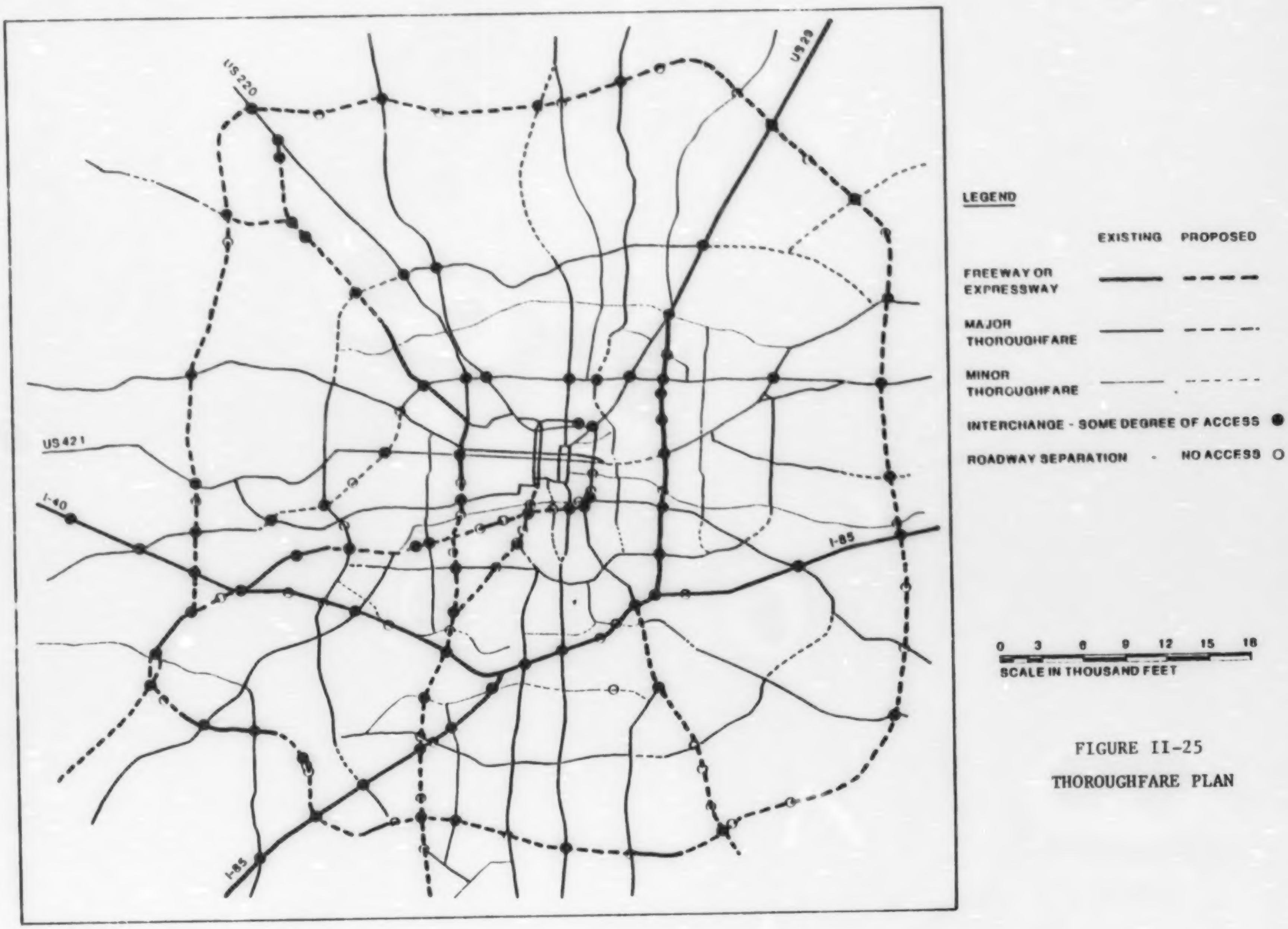

US220
US29
US421
I-40
I-85
I-85
LEGEND
EXISTING
PROPOSED
FREEWAY OR EXPRESSWAY
MAJOR THOROUGHFARE
MINOR THOROUGHFARE
INTERCHANGE - SOME DEGREE OF ACCESS ●
ROADWAY SEPARATION - NO ACCESS ○
0
3
6
9
12
15
18
SCALE IN THOUSAND FEET

FIGURE II-25

THOROUGHFARE PLAN

Greensboro (CL-093). No public power plants are in Guilford County.

The Greensboro District of Duke Power serves most of Guilford County with the exception of High Point and Jamestown. The electricity consumption for the district for the past twelve months appears in the Technical Reference Document (RA-R-406). Residential use varies seasonally while commercial and government (city lights, etc.,) hold rather constant. The industrial use has been rising lately from a period of industrial cutbacks.

b. Projected Electrical Use

Duke Power forecasts that consumption of electricity will increase by 7 to 8% annually (HO-318). Company officials state that Duke Power can easily accommodate this growth and that the company is currently operating with a reserve capacity of 35% (HO-318).

Also, it would appear that Duke Power is in a favorable position for providing projected energy needs because of the type of fuels used. In 1975, 62% of the energy came from coal, 34% from nuclear plants, and 6% from hydroelectric plants. The 2% excess was sold to other plants (HO-318). Obviously, Duke Power is currently free from dependence on oil or gas.

c. Natural Resource Users

Mining in Guilford County as of January 1976 was limited to crushed stone, sand and gravel, and clay. Crushed stone is the only resource mined in the study area (MC-249). The locations of these mineral extraction areas are presented in the Technical Reference Document (RA-R-406). No coal, oil, or natural gas is found in Guilford County.

8. Water and Wastewater Services

a. Water Supply and Distribution

Water supplies for the City of Greensboro are drawn from a complex of three reservoirs on Reedy Fork Creek including Lake Higgins, Lake Brandt, and Lake Townsend. This system of lakes has an estimated safe water supply yield of 46 MGD (HA-544). Raw water is treated at either the Townsend Filter Plant or the Mitchell Filter Plant which have filter capacities of 20 MGD and 24 MGD respectively. This water treatment capacity should be adequate throughout the design period of the project. The geographical location of the water supply and distribution facilities for Greensboro are shown on Figure II-26. Included are the locations for the two filter plants and points of water supply withdrawal, storage facilities, and water distribution lines of 12-inch diameter or larger (HA-544).

The combined maximum and minimum, monthly daily average and the average pumpage rate for both the N.L. Mitchell and Lake Townsend pumping stations and the maximum and minimum monthly daily average and the average water sold for 1975 and through September of 1976 are presented in Table II-39. The average water supply pumpage for Greensboro was 20.57 MGD in 1975 and was 21.52 MGD in 1976. The average water sold was 18.13 MGD in 1975 and was 19.26 MGD in 1976.

According to current water rate schedules for users both inside and outside the city, rates for users outside the city are approximately double those of users inside the city. Additionally, users outside the city must pay an assessment to the county which is determined by the acreage and front footage of the

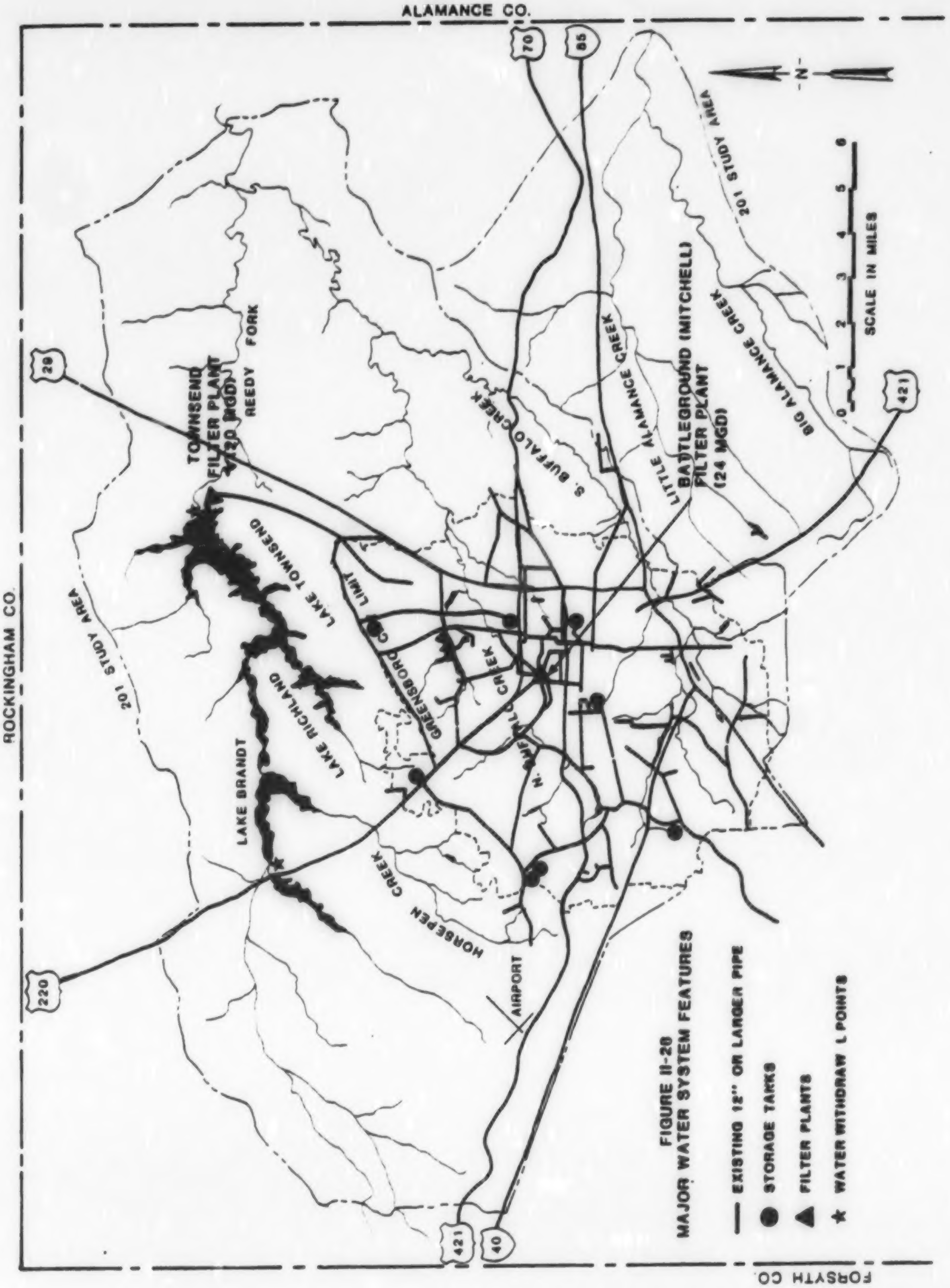

ALAMANCE CO.
ROCKINGHAM CO.
FORSYTH CO.
70
85
29
220
421
40
N
201 STUDY AREA
TOWNSEND FILTER PLANT (20 MGD)
REEDY FORK
LAKE TOWNSEND
LAKE RICHLAND
LAKE BRANDT
S. BUFFALO CREEK
LITTLE ALAMANCE CREEK
BATTLEGROUND (MITCHELL) FILTER PLANT (24 MGD)
BIG ALAMANCE CREEK
GREENSBORO CITY LIMIT
N. BUFFALO CREEK
HORSEPEN CREEK
AIRPORT
0 1 2 3 4 5 6
SCALE IN MILES
EXISTING 12" OR LARGER PIPE
STORAGE TANKS
FILTER PLANTS
WATER WITHDRAW L POINTS

FIGURE II-20
MAJOR WATER SYSTEM FEATURES

TABLE II-39
MAXIMUM AND MINIMUM MONTHLY DAILY AVERAGE AND AVERAGE WATER SUPPLY PUMPED AND SOLD FROM N.L. MITCHELL AND LAKE TOWNSEND PUMPING STATIONS

	Sold (MGD)		Sold (MGD)	
	1975	1976	1975	1976
Maximum	22.50	22.58	20.58	21.24
Minimum	19.00	20.02	15.71	16.94
Average	20.57	21.52	18.13	19.26

property served before receiving services. All distribution lines inside and outside the city are maintained by the city.

The present approximate quantity of municipal and industrial water use in Greensboro is given in Table II 40. Present municipal water use is approximately 15.85 MGD and major industry water use is approximately 5.67 MGD.

TABLE II-40
ESTIMATED PRESENT WATER USE IN GREENSBORO, NORTH CAROLINA

User	Water Use (MGD)
Municipal	15.85
Industrial	5.67
Total	21.52

b. Wastewater Collection and Treatment

The City of Greensboro currently maintains a separate type wastewater collection system with approximately 720 miles of outfall sewers and approximately 14 miles of force main (HA-544).

A report on the infiltration/inflow analysis completed in November 1973 concludes that the existing wastewater collection system currently experiences excessive infiltration/inflow with an approximate excess infiltration of 0.7 MGD and 1.3 MGD for the North Buffalo Creek collection system and South Buffalo Creek collection system, respectively. That report recommends that for projecting future wastewater flows a non-excessive infiltration of 0.7 MGD and 0.9 MGD be assumed for the North and South Buffalo Creek collection systems, respectively. Additionally, it is recommended that respective allowable inflow of 18 MGD and 9.5 MGD above the dry day peak flows be included for design flow adjustment. A new infiltration/inflow evaluation survey is currently in progress. This survey will locate areas of excessive infiltration/inflow and will propose corrective measures; preliminary results of this study indicate that a non-excessive infiltration/inflow of 2.7 MGD will be recommended for design purposes.

The city is serviced by two wastewater treatment facilities including the North Buffalo Creek Plant with an approximate capacity of 18 MGD and the South Buffalo Creek Plant with an approximate capacity of 11 MGD.

The location of major gravity sewers, pump stations, force mains, and the two wastewater treatment facilities are shown in Figure II-27. Wastewater discharged to the North Buffalo treatment facility is predominantly domestic, and the majority of the industrial wastewater generated in Greensboro is discharged to the South Buffalo Creek Plant. Approximately four industries not including restaurants and laundries discharge to the North Buffalo Creek Plant with a total average daily flow of approximately 0.730 MGD. Approximately 18 industries not including restaurants and laundries discharge to the South Buffalo Creek Plant with a total average daily flow of approximately 4.383 MGD.

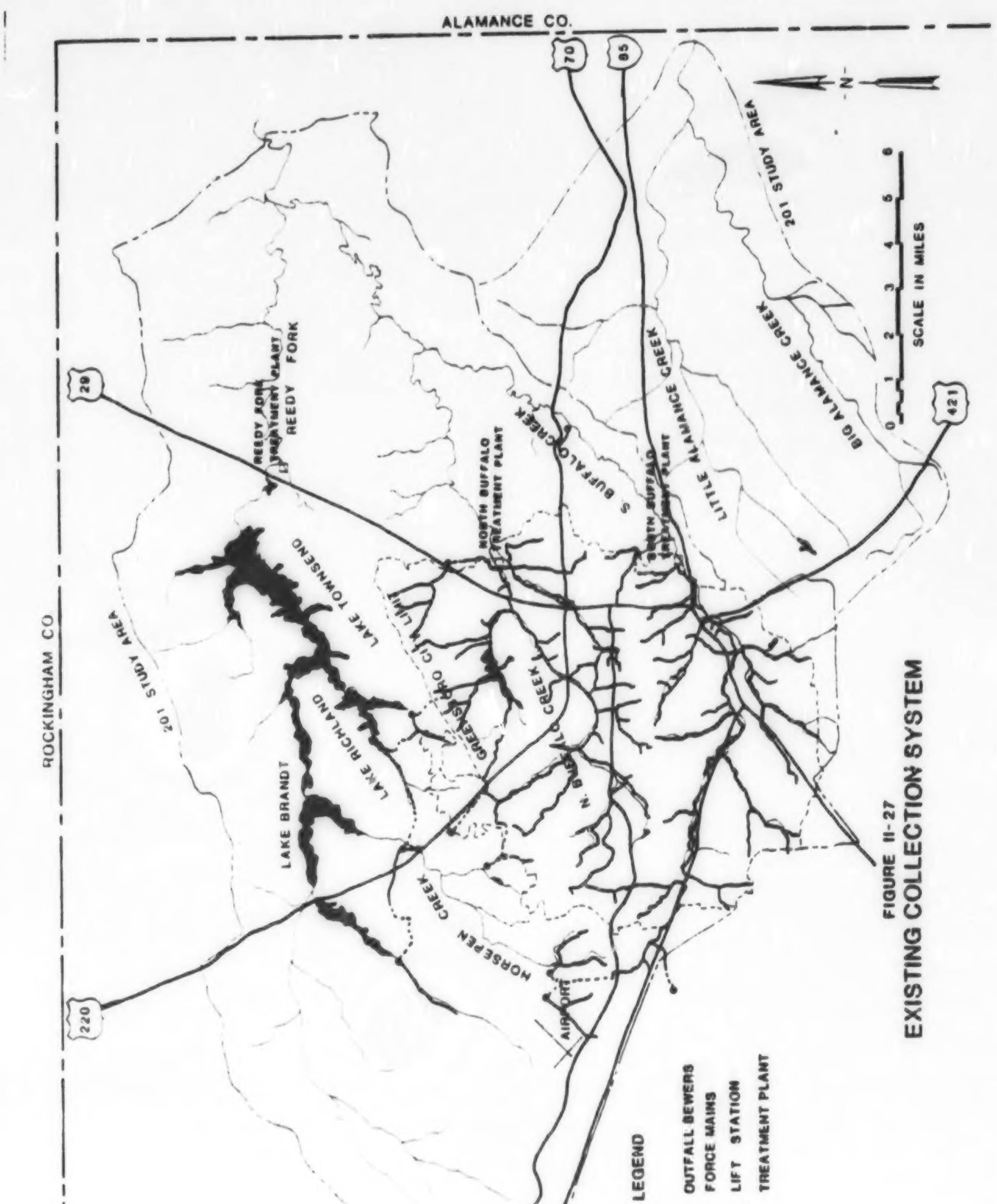

ALAMANCE CO.
ROCKINGHAM CO
FORSYTH CO
70
85
29
421
220
421
40
N
201 STUDY AREA
201 STUDY AREA
REEDY FORK
REEDY FORK TREATMENT PLANT
REEDY FORK
NORTH BUFFALO TREATMENT PLANT
S. BUFFALO CREEK
SOUTH BUFFALO TREATMENT PLANT
LITTLE ALAMANCE CREEK
BIG ALAMANCE CREEK
LAKE TOWNSEND
LAKE BRANDT
LAKE RICHLAND
GREENSBORO CITY LIMIT
N. BUFFALO CREEK
HORSEPEN CREEK
AIRPORT
0 1 2 3 4 5 6
SCALE IN MILES
LEGEND
OUTFALL SEWERS
FORCE MAINS
LIFT STATION
TREATMENT PLANT

FIGURE II-27
EXISTING COLLECTION SYSTEM

The North Buffalo Creek treatment facility treats and discharges an average flow of approximately 10 MGD. Primary treatment is provided by four rectangular primary sedimentation tanks which have a total volume of 1,150,000 cubic feet, a total surface area of 12,800 square feet, and a total treatment capacity of approximately 20.5 MGD. Secondary treatment is accomplished with trickling filters followed by aeration facilities. The two trickling filters have a total volume of 251,200 cubic feet and a design capacity of approximately 20 MGD. The four rectangular aeration tanks have a total volume of 580,000 cubic feet and an approximate design capacity of 20.5 MGD. Air is supplied through diffused aeration facilities which have a capability of delivering approximately 14,000 CFM. Final clarification is accomplished with five circular sedimentation tanks which have a combined surface area of 26,000 square feet and a total design capacity of approximately 20.8 MGD based on an overflow rate of 800 gpd per square foot. Before discharge to North Buffalo Creek, the treated wastewater receives chlorination in a 35,800 cubic foot rectangular chlorine contact chamber capable of providing 30 minutes of contact for a maximum daily flow of 13 MGD (HA-527).

Mixed primary and thickened waste-activated sludge is dewatered by vacuum filters before incineration and final disposal of the ash at the state-approved White Street landfill adjacent to the plant site (HA-527).

The South Buffalo Creek treatment facility treats and discharges an average flow of approximately 9.6 MGD. Primary treatment is provided by one square and one circular primary sedimentation tank which have a total volume of approximately 94,300 cubic feet, a total surface area of approximately 9,924 square feet, and a total treatment capacity of approximately 16 MGD (HA-527). Secondary treatment is accomplished with trickling filters followed by aeration facilities. The two trickling filters have a total volume of 265,000 cubic feet and a design capacity as roughing filters of approximately 9.1 MGD. The four rectangular aeration tanks have a total volume of 652,400 cubic feet and a hydraulic design capacity of approximately 15 MGD. Air is supplied by platform-mounted surface aeration and floating surface aerators. The mounted aerators have a combined capacity of 200 h.p. and the floating aerators have a combined capacity of 360 h.p. Final clarification is accomplished with two circular sedimentation tanks which have a combined surface area of 17,300 square feet and a total design capacity of approximately 10 MGD. Before discharge to South Buffalo Creek, 6 MGD of treated wastewater is filtered through tertiary sand filters and receives chlorination in a 25,000 cubic foot chlorine contact chamber capable of providing 30 minutes of contact for a maximum daily flow of 12 MGD (HA-527).

Mixed primary and thickened waste-activated sludge is dewatered by vacuum filters before transport to the North Buffalo Creek Plant for incineration. Ash is disposed of at the White Street landfill (HA-527).

The average influent and effluent quality concentrations with respect to biochemical oxygen demand (BOD) and suspended solids (SS) at both the North Buffalo and South Buffalo Creek wastewater treatment facilities are given in Table II-41. The North Buffalo Creek plant discharges an effluent with an average BOD concentration of approximately 14 mg/ℓ and an average suspended solids concentration of approximately 20 mg/ℓ, while the South Buffalo Creek plant discharges an effluent with an average BOD concentration of 31 mg/ℓ and an average suspended solid concentration of approximately 54 mg/ℓ. The lower quality effluent at the South Buffalo Plant probably is a result of the larger portion of industrial wastewater discharged to that plant and

TABLE II-41
INFLUENT AND EFFLUENT QUALITY AT NORTH AND SOUTH BUFFALO CREEK WASTEWATER TREATMENT FACILITIES

Treatment Facility	BOD (mg/ℓ) Influent	BOD (mg/ℓ) Effluent	BOD (mg/ℓ) % Removal	SS (mg/ℓ) Influent	SS (mg/ℓ) Effluent	SS (mg/ℓ) % Removal
North Buffalo	288	14	95	150	20	80
South Buffalo	264	31	88	248	54	78

the lack of sufficient oxygen transfer facilities. Additionally, the South Buffalo Plant is operating near its peak hydraulic capacity, whereas the North Buffalo Plant is operating at approximately 50 percent of its hydraulic capacity. Both treatment plants suffer foaming problems, possibly resulting from oil and grease or surfactants contained in the influent wastewater which are not removed in the treatment process.

Charges for domestic wastewater services are equal to 100 percent of the water rates. Charges for industrial wastewater services are stipulated in the City of Greensboro's sewer ordinance which identifies surcharges applicable to users with strong wastewaters. A uniform charge rate schedule will become effective in July, 1977 (HA-527).

III. SYSTEM ALTERNATIVES

A. Introduction

The Federal Water Pollution Control Act Amendments of 1972 (FWPCAA: PL 92-500) were designed to establish a water pollution control program to protect the nation's navigable waters. The pollution control program which was established by this law includes federal standards for industrial and municipal waste treatment and provisions for federal enforcement, a permit and license system (National Pollutant Discharge Elimination System) which governs the discharge of pollutants into navigable waters, and a massive grant-in-aid program for the construction of publicly-owned waste treatment works.

The basic objective of the FWPCAA is to eliminate the discharge of pollutants into waters of the United States by 1985. The feasibility or environmental desirability of meeting this "zero discharge" goal by 1985 has not been established. However, the less stringent interim goals and requirements established for 1977 and 1983 will be enforced. Therefore, the Division of Environmental Management (DEM) of the State of North Carolina, in accordance with Section 303(e) of the FWPCAA has prepared a management plan for the Cape Fear River Basin. This basin plan, specifically the subbasin 02 plan, identifies those treatment levels required to protect the water quality of these rivers and their tributaries of the Greensboro area to levels consistent with the 1977 and 1983 interim goals. It is the objective of the City of Greensboro, North Carolina, to participate in this federal pollution control program, specifically that authorized by Section 201 of PL 92-500, to achieve the current and future water quality goals and requirements by providing expanded and upgraded wastewater treatment facilities for both municipal and industrial use. The city in pursuit of these goals will comply with Section 301 of PL 95-500 which mandates that the discharge of any pollutant meet water quality standards.

B. Design Flow

The City of Greensboro is currently serviced by two municipal wastewater treatment facilities including the North Buffalo Creek treatment plant and the South Buffalo Creek treatment plant which have a combined hydraulic treatment capacity of approximately 29 MGD. With a present wastewater flow of approximately 21 MGD, the existing facilities are hydraulically adequate. However, neither wastewater treatment plant is capable of producing a high quality effluent as required by law. Therefore, the City of Greensboro must, at minimum, upgrade its wastewater treatment capability to comply with federal and state laws.

Design flow analysis was based upon forecasted requirements for a 20-year timeframe. The selection of a proper design flow for both legal and planning purposes is essential before reasonable subsystem and system alternatives can be identified and developed. Additionally, this total design flow must be disaggregated into the respective drainage areas from which it emanates to aid in selection of candidate sites and appropriate design capacities of proposed or existing wastewater treatment plants.

To determine an appropriate design flow, the U.S. Environmental Protection Agency has designated two methodologies as acceptable for use. The major difference in the two is the method by which future industrial flows are projected. The "OBERS"[1] methodology assumes that the past and present relationships between industrial flows and industrial economic conditions including employment and total earnings will persist. For this method, the Office of Business Analysis and Economic Research

---

[1] OBERS is a joint venture of several government agencies for demographic and economic projections of common interest, sponsored by the U.S. Water Resources Council.

Service's industrial earnings projections can be applied accordingly to the respective SMSA's[2] present industrial flows to project future industrial flows. This methodology requires a significant quantity of information from both city and industrial records to establish the appropriate and acceptable relationships. Since the city records were not in a form that is readily available and since specific industries expressed a reluctance to provide the necessary, yet proprietary, information, the "OBERS" methodology could not be used for this study. A more detailed description of the appropriate use of OBERS economic projections, as defined by EPA and DNER, is provided in the Technical Reference Document (RA-R-406).

The second acceptable methodology for determining the 20-year design flow assumes that industrial growth will approximate ten percent of the total present and future municipal flow, present industrial flow, and allowable infiltration/inflow. Additional industrial capacity can be acquired from letters of intent from industries indicating their future treatment capacity needs. This adjusted design flow will be used for facilities' planning purposes only. Before Step II funding or design can proceed, the future industrial flows established by the letters of intent from industries must be substantiated. This substantiation will consist of a letter of commitment from the participating industries, verifying their responsibility to comply with all user charge and cost recovery requirements associated with that additional flow. If the letters of commitment are not forthcoming, the design flow for Step II will be adjusted downward accordingly. Step II funding includes the detailed design drawings and specifications for the proposed wastewater treatment system.

The design flow for the City of Greensboro was established using the "ten percent" method. Using various assumptions and projections for percent of population served in the study area and per capita wastewater flow, the predicted design flow can range from approximately 29 MGD to 39 MGD. A design flow of 36 MGD was selected for purposes of the alternatives development. This figure includes industrial letters of intent for reserve capacity of 1.5 MGD and a per capita wastewater flow increase over the design period of approximately 10 percent, which eliminates considerations for water conservation measures in this potentially water short area.

---

[2] Standard Metropolitan Statistical Area - a region composed of one or more counties functionally tied to a central city of 50,000 or more people.

The total design flow of 36 MGD is disaggregated into respective drainage areas from which it emanates to help locate and size alternative wastewater treatment facilities. Using population and industrial growth forecasts, the projected flow was disaggregated as shown in Table III-1. With 18 MGD of wastewater generated from the South Buffalo service area and an additional 2.0 MGD from downstream of the South Buffalo service area, which includes the Alamance Creek area, the minimum capacity of a facility treating wastewater from this area is 20 MGD. Facilities designed to treat wastewaters generated in the North Buffalo Creek service area should have a minimum capacity of 13.6 MGD. If wastewater generated in the Horsepen Creek area is transferred to the North Buffalo Creek service area, the design flow should be increased by 2.4 MGD to 16.0 MGD resulting in a total design capacity of 36 MGD.

TABLE III-1

DISAGGREGATED DESIGN FLOW FOR CITY OF GREENSBORO, N.C.

Source	South Buffalo	South Buffalo (Downstream)	North Buffalo	Horsepen Creek	Design Year Total
Domestic & Commercial	9.9	0.9	9.7	1.2	21.7
Institutional	0.3		1.0		1.3
Industrial					
Existing	3.7		1.5	0.5	5.7
Future	1.5	1.0		0.6	3.1
Intent	1.5				1.5
Infiltration/Inflow	1.1	0.1	1.4	0.1	2.7
Total	18.0	2.0	13.6	2.4	36.0

C. Development of System and Subsystem Alternatives

1. Approach

The selection of reasonable system and subsystem alternatives for expanding and/or upgrading the existing wastewater treatment facilities is responsive to the inability of the present facilities to meet proposed standards. Deficiencies occur when a facility or system does not have the capacity to treat the projected flow and/or it cannot produce the desired level of treatment.

A set of eight system alternatives, exclusive of No Action, were identified and recommended for evaluation in the 201 Facilities Plan and in public hearings concerning this project. These alternatives were based on a design flow substantially different from that established for this EIS and, therefore, are not applicable to this program. Consequently, a new set of system alternatives had to be derived for evaluation. To develop the system and subsystem alternatives necessary to attain the project goals, the capacity and treatment capability of the existing unit processes were inventoried. After completion of this task, all reasonable methods of discharge and locations for new or existing facilities were determined from which effluent limitations were assigned. Finally, the most cost-effective unit processes for meeting these limitations were selected for each facility and the system and subsystem alternatives were identified. Detailed evaluations of these identified alternatives provided the basis for selection of the proposed action.

2. Capability of Existing Facilities

The North Buffalo Creek plant has a hydraulic design capacity of approximately 18 MGD and the South Buffalo Creek plant has a hydraulic design capacity of approximately 11 MGD. With a total design flow capacity of approximately 29 MGD, the Greensboro wastewater treatment facilities are hydraulically adequate to treat the present flow of approximately 21 MGD but must be expanded to provide the 20-year design capacity of 36 MGD.

From data reported during a 21-month period from January 1975 to September 1976, the North Buffalo plant discharges an average daily flow of approximately 10.8 MGD with an average 5-day biochemical oxygen demand (BOD_5) concentration of approximately 16.0 mg/ℓ and a Total Suspended Solids (TSS) concentration of approximately 23.0 mg/ℓ. This level of treatment represents a treatment efficiency of approximately 93 percent. The South Buffalo plant currently discharges an average daily flow of approximately 9.5 MGD with an average BOD_5 concentration of approximately 35.3 mg/ℓ and an average TSS concentration of approximately 50.5 mg/ℓ for a total treatment efficiency of approximately 87 percent. Neither plant currently monitors for ammonia-nitrogen (NH_3-N) concentration, but little removal is expected owing to inadequate aeration facilities at both sites. A detailed inventory of existing wastewater treatment facilities and sludge handling facilities, including design criteria and capacity, is provided in the Technical Reference Document (RA-R-406).

3. Wastewater Treatment Process Alternatives

A list of all available unit processes for the treatment of municipal and industrial wastewaters is extensive and will not be discussed in detail. However, a general discussion of physical/chemical and biological systems follows.

a. Physical/Chemical Processes

Considerations for physical/chemical processes for treatment of wastewaters usually includes sedimentation, chemical precipitation, activated carbon adsorption, filtration, and disinfection. Ion exchange and pH control for air stripping are sometimes considered for removal of ammonia.

Physical/chemical processes are also often employed for sludge treatment and disposal. These processes may include vacuum filters or centrifuges for dewatering, sand drying beds for sludge drying, and incinerators. Other forms of heat treatment are also used.

Physical/chemical processes are most applicable for treating wastewaters which are not amenable to biological treatment. Capital costs for physical/chemical facilities are usually about the same as a biological system but operation and maintenance costs are generally much higher owing to chemical cost and possible excess sludge production.

Physical/chemical processes are most often used in combination with biological facilities. The most common uses include preliminary treatment including bar racks and screens, comminutor, grit collection and removal, primary sedimentation or clarification, and disinfection with either chlorination or ozonation.

b. Biological Processes

Biological processes are used for both the treatment of wastewaters and stabilization of organic sludges. Secondary treatment is often accomplished with biological trickling filters or one of several modifications of the activated sludge process. These modifications include conventional activated sludge, contact stabilization, step aeration, and extended aeration and are usually followed by secondary clarification.

Nitrification, i.e., the oxidation of organic nitrogen and ammonia to nitrite and nitrate, can be achieved with activated sludge if sufficient aeration is supplied and a long detention time is allowed. Additionally, denitrification or the reduction of nitrates to nitrogen gas, can be accomplished biologically under anaerobic conditions if a supplementary organic energy source is added.

Primary and waste activated sludges can be stabilized biologically in either anaerobic or aerobic digestion. Either process can produce a relatively inert, easily dewatered material acceptable for disposal in a public landfill site.

4. Effluent Disposal Alternatives

The four most common methods of final disposal of treated effluent include direct discharge to receiving streams, land application, recycle/reuse, and subsurface injection. Currently, the two existing treatment facilities discharge directly to the North and South Buffalo Creeks.

a. Direct Discharge to Receiving Streams

Direct discharge to receiving streams is the most common method employed for ultimate disposal of treated wastewater. The level or degree of treatment required is dependent on the downstream usages of the water and the capacity of the receiving stream to assimilate the pollutional load discharged. Receiving streams with a low assimilative capacity will require a higher quality effluent to maintain a fixed level of dissolved oxygen content. This case is characteristic of the North and South Buffalo Creeks in Greensboro.

b. Land Application

Land application of pretreated wastewaters can be an economically attractive alternative because a lesser degree of treatment may be required and valuable nutrients including nitrogen and phosphorus can be recycled onto cropland. Additionally, assuming proper performance, treated wastewaters are removed from the area streams. However, according to the Soil Conservation Service surveys, with the exception of only a few locations, soils in the Greensboro area are generally unsuitable for land application practices. Assuming an application rate of 0.25 inches/day, approximately 10 square miles of disposal field would be required. Therefore, it is doubtful that permits for such practices could be secured and effluent land application practices are not considered practicable for this area.

c. Recycle/Reuse

Direct recycle for industrial or municipal demands can offer a potential for reuse of treated wastewater. The level or degree of treatment required is contingent on the specific use intended for the recycled wastewater.

The most probable municipal use for recycled wastewater is to augment the regional water supply. Unless additional resources are provided, Greensboro water demands will approach existing supply resources near the end of the design period. However, because existing water supplies are marginally adequate and plans for additional resources are currently being investigated, water reuse for municipal water supplies is not considered in this study. If in the future water supply resources do become scarce, additional treatment processes can be incorporated in the existing or proposed facilities to allow for municipal recycle, assuming public approval is obtained. Because public approval or acceptance could prove to be prohibitive, it is recommended that the city resolve the public acceptance question in advance in the event such recycle becomes necessary.

d. Subsurface Injection

The lack of suitable subsurface formations in the study area prohibit the use of subsurface disposal methods.

5. Sludge Disposal Alternatives

Sludge handling facilities at the North Buffalo plant include thickeners, vacuum filters for dewatering, and incineration. Ash is hauled to the nearby existing landfill site. A two-stage anaerobic digestion facility for waste stabilization is also available but is used only as a back-up to the vacuum filters and incinerators.

Sludge handling facilities at the South Buffalo plant include thickeners and vacuum filters. The dewatered sludge is trucked to the North Buffalo plant for incineration and ultimate disposal of ash at the existing landfill site. A single-stage anaerobic digestion facility is also available but has not been used recently owing to the toxicity characteristics of the industrial waste loads which prohibit proper biological degradation for digestion.

Currently, a sludge management study is being conducted at the South Buffalo plant. The intent of this study is to develop a suitable sludge management scheme for the existing Greensboro facilities. One possibility being considered includes the production of an acceptable non-toxic soil amendment or conditioner for public use. This process includes stabilization of both primary and waste-activated sludge through anaerobic digestion, followed by dewatering with the existing vacuum filters. The stabilized dewatered sludge will be stockpiled near the vicinity of the South Buffalo plant and will be made available to the public as a soil conditioner. The success of this scheme will be largely dependent on the public acceptance and demand for the finished product.

Another possible sludge handling alternative which should be considered, especially for new treatment facilities, is aerobic digestion. These facilities minimize odor problems associated with sludge disposal and produce a well-stabilized sludge. Dewatering can be accomplished with either vacuum filters or centrifuge and sand drying beds can be considered for further drying. Sludge processed in this manner can be either disposed of in a sanitary landfill or land-spread with little environmental problems.

Large-scale land application of stabilized liquid sludge can be accomplished using tank trucks or spray irrigation facilities. However, as with land application of treated effluents, the soils in the study area are generally unsuitable for such practices.

6. Non-Structural Alternatives

Non-structural alternatives can be implemented to help reduce water quality problems by discouraging the use of water and, consequently, the discharge of wastewater. Non-structural alternatives include flow and waste reduction measures such as industrial water reuse and recycling, land use, zoning controls, negative or no growth policies, education programs for decreased water use and wastewater generation, and water and sewer rate structure alternatives. These non-structural alternatives were considered in determining the design flow of 36.0 MGD but were found to be either not applicable or of little significance.

To arrive at a design flow of 36.0 MGD it was assumed that the per capita waste flow would increase by approximately 10 percent and that 95 percent of the EIS Study Area would be as intensely developed, i.e., serviced with municipal water and sewers, as the city is today. The flow calculation assumes a 50 percent growth in population with a corresponding 71 percent increase in wastewater flow.

Other non-structural alternatives include improved operation and maintenance techniques, non-point source controls, and institutional arrangements for combining facilities and wastewater discharges. Improved operation and maintenance techniques will help insure a consistently high quality wastewater. With the design of a Class I reliability system it is required that the city staff the facility with certified operators and technicians to insure proper operation and maintenance.

Urban and agricultural non-point source discharges are difficult to control with current technology. The initial step is an attempt to control non-point sources and to identify the source and magnitude of any problem. The level of effort required to complete this task is out of scope for development of this EIS. However, the results of the current non-point source monitoring program in the Horsepen Creek drainage basin may be useful for making projections and identifying potential problems.

Institutional arrangements to combine facilities and wastewater discharges have only limited applicability in Greensboro. The three major sources of wastewater discharge include the two municipal wastewater treatment facilities and Cone Mills industries. Cone Mills treats and discharges approximately 3.50 MGD of wastewater just upstream of the North Buffalo plant. Possibilities for other industrial wastewater hook-ups with the existing facilities should be investigated. While these industries discharge a relatively small volume of wastewater, the pollutant loading can be significant.

7. Location Alternatives

All reasonable and technically feasible wastewater treatment systems with respect to plant siting which can be incorporated with the existing facilities to satisfy the objectives and requirements for the City of Greensboro are identified and are presented in the Technical Reference Document (RA-R-406). The location of all candidate treatment plant sites are shown in Figure III-1. The alternatives list in the Technical Reference Document includes basically 124 system alternatives which identify one, two, and three plant configurations. Alternatives which consider a new facility do not, at this level, specify where this facility will be located, but instead only recognize a new facility in another location. In most cases the new facility can be reasonably located at any one of a number of sites.

Where applicable, phased construction is considered to allow for flexibility for future expansion. The date at which such phased expansion should occur, based on a design flow of 36 MGD, is provided in the list.

Forty-eight of the apparently more promising system alternatives were selected as indicators for further evaluation. This selection did not eliminate any system alternatives originally identified but, by working with a smaller set of alternatives, provided a means by which engineering, environmental, and economic judgements could be verified. These forty-eight alternatives are identified and noted on the list in the Technical Reference Document (RA-R-406).

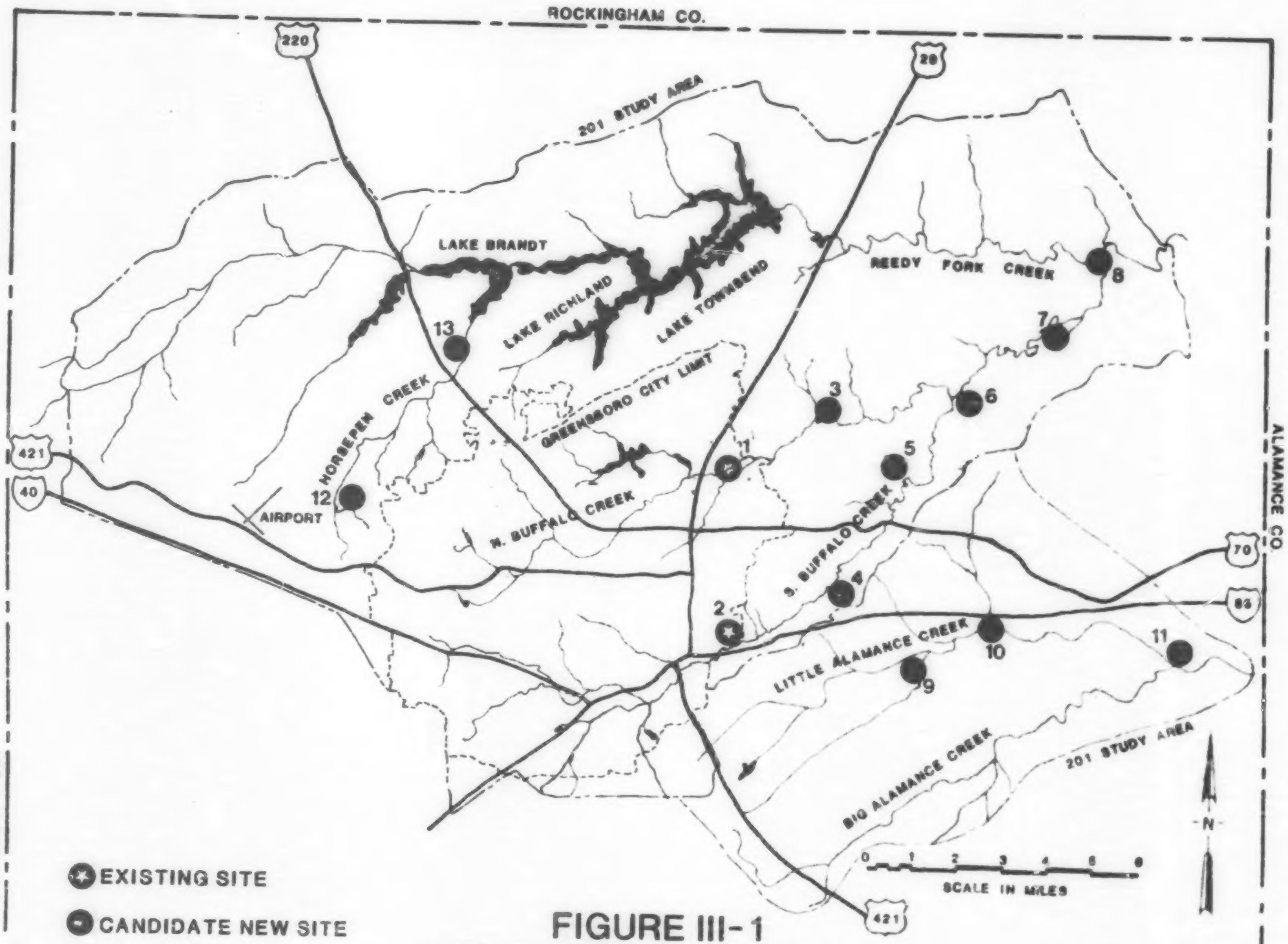

ROCKINGHAM CO.
ALAMANCE CO.
FORSYTH CO.
220
29
421
40
70
85
421
201 STUDY AREA
LAKE BRANDT
LAKE RICHLAND
LAKE TOWNSEND
REEDY FORK CREEK
GREENSBORO CITY LIMIT
HORSEPEN CREEK
N. BUFFALO CREEK
S. BUFFALO CREEK
LITTLE ALAMANCE CREEK
BIG ALAMANCE CREEK
201 STUDY AREA
AIRPORT
1
2
3
4
5
6
7
8
9
10
11
12
13
N
0 1 2 3 4 5 6
SCALE IN MILES
EXISTING SITE
CANDIDATE NEW SITE

FIGURE III-1
LOCATION OF EXISTING AND
CANDIDATE WWT PLANT SITES

These selected alternatives were examined on a "high level" economic and environmental basis. Calculations for the preliminary economic analysis are based on the assumption that each plant will provide a tertiary level of treatment with nitrification followed by multimedia filtration. In all cases, sludge handling facilities included dewatering with vacuum filters prior to incineration and ultimate disposal of ash at the existing landfill site.

The results of the preliminary analysis along with schematics of forty of the alternatives examined are provided in the Technical Reference Document (RA-R-406). The "rough" cost figures provided are intended for screening purposes only and are not to be interpreted as final cost estimates for the EIS.

After review of the preliminary evaluations, all system alternatives originally identified were screened to select candidate alternatives for detailed environmental and economic analysis. The basis for screening alternatives and the specific reason why each alternative not selected was eliminated is provided in the Technical Reference Document (RA-R-406). Eleven alternatives, including No Action, survived this screening process. These eleven alternatives include 4, three modifications of 15, 40, 42, 46, 70, 85, and 85 without phasing from the original list. A brief description of these alternatives is provided on a separate list in the Technical Reference Document (RA-R-406). After further consideration, five of these remaining alternatives were eliminated and two additional alternatives were included. Reasons for this screening are also provided in the Technical Reference Document (RA-R-406). Those system alternatives selected to receive further economic and environmental evaluation include numbers 4, four modifications of 15, and 70, as well as No Action, and henceforth will be referred to as system alternatives numbers 1 through 7, respectively. The four modifications of Alternative 15 differ only in the location of a new 20 MGD plant. In all cases, the new facility is located downstream of the existing South Buffalo Creek facility on either South Buffalo Creek, the confluence of North and South Buffalo Creeks, or Buffalo Creek.

D. Description of Alternatives Selected for Evaluation

A total of 7 system alternatives, including the No Action alternative, received detailed environmental and cost evaluation. A summary description of these alternatives is provided in Table III-2.

To maintain the existing facilities as they are now operating would constitute a type of "no action" approach to wastewater treatment. However, regulatory constraints which control the discharge of wastewater clearly eliminate a true "no action" alternative. Consideration of a "no acton" alternative is mandated by the CEQ guidelines for the National Environmental Policy Act. Therefore, the No Action alternative was defined to include upgrading but no expansion of existing facilities to meet 1983 discharge requirements. This No Action alternative also would involve expenditure of federal and state funds.

Detailed descriptions with location maps of the various components required for each of the system alternatives are presented. This information was used for both the environmental and economic assessment of these alternatives. For purposes of comparison, a map description of the existing facilities is provided in Figure III-2.

Alternative 1 - Upgrade the North Buffalo Creek facility to provide a tertiary level of treatment at 16.0 MGD; upgrade and expand the existing South Buffalo Creek facility to provide a tertiary level of treatment at 20.0 MGD;

TABLE III-2

SUMMARY OF SYSTEM ALTERNATIVES EVALUATED IN THE ENVIRONMENTAL IMPACT STATEMENT

	NORTH BUFFALO PLANT	SOUTH BUFFALO PLANT	NEW SITE 14,000 L.F. DOWNSTREAM OF SOUTH BUFFALO PLANT	NEW SITE 25,000 L.F. DOWNSTREAM OF SOUTH BUFFALO PLANT	NEW SITE AT CONFLUENCE OF NORTH AND SOUTH BUFFALO CREEKS	NEW SITE BELOW CONFLUENCE ON BUFFALO CREEK
EXISTING FACILITIES	18 MGD	11 MGD				
ALTERNATIVES						
1	16 MGD	20 MGD				
2	16 MGD		20 MGD			
3	16 MGD			20 MGD		
4	16 MGD				20 MGD	
5	16 MGD					20 MGD
6	**16 MGD***	11 MGD				
7 NO ACTION	**18 MGD**	**11 MGD**				

***Will be expanded to 25 MGD in 1987**

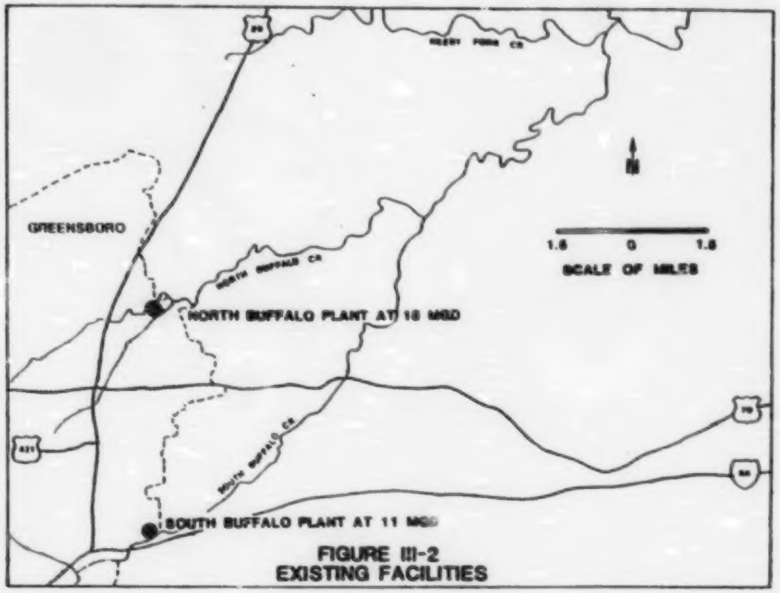

29
REEDY FORK CR
GREENSBORO
N
1.5
0
1.5
SCALE OF MILES
NORTH BUFFALO CR
NORTH BUFFALO PLANT AT 16 MGD
SOUTH BUFFALO CR
421
70
85
SOUTH BUFFALO PLANT AT 11 MGD

FIGURE III-2
EXISTING FACILITIES

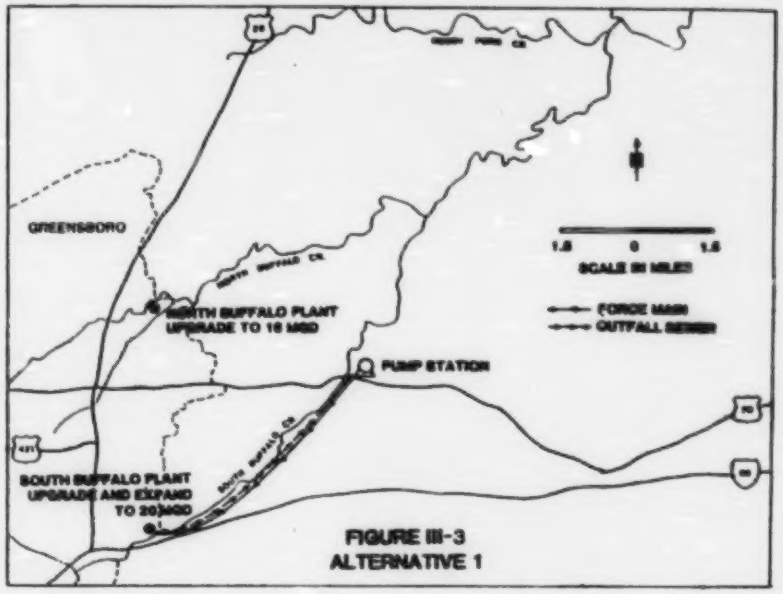

29
REEDY FORK CR
GREENSBORO
1.5
0
1.5
SCALE IN MILES
FORCE MAIN
OUTFALL SEWER
NORTH BUFFALO CR
NORTH BUFFALO PLANT
UPGRADE TO 16 MGD
PUMP STATION
SOUTH BUFFALO CR
421
70
85
SOUTH BUFFALO PLANT
UPGRADE AND EXPAND
TO 20 MGD

FIGURE III-3
ALTERNATIVE 1

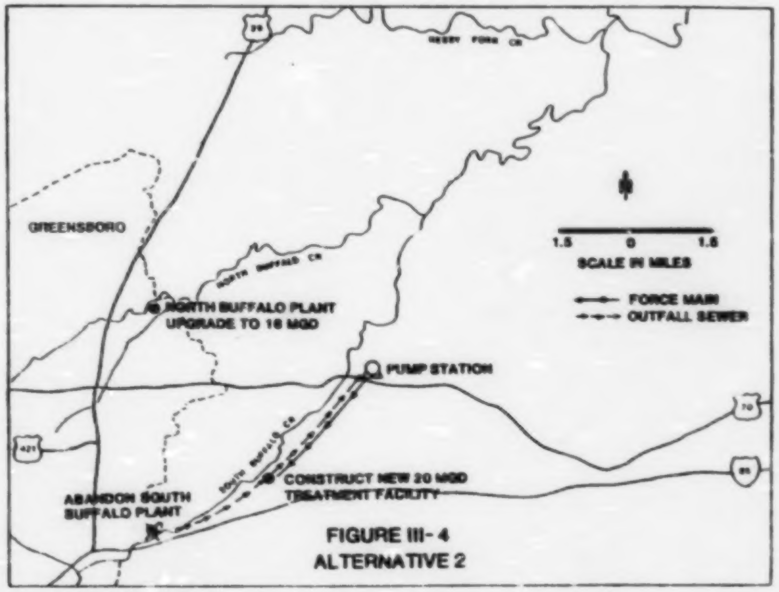

29
REEDY FORK CR
GREENSBORO
1.5
0
1.5
SCALE IN MILES
FORCE MAIN
OUTFALL SEWER
NORTH BUFFALO CR
NORTH BUFFALO PLANT
UPGRADE TO 16 MGD
PUMP STATION
SOUTH BUFFALO CR
421
70
85
CONSTRUCT NEW 20 MGD
TREATMENT FACILITY
ABANDON SOUTH
BUFFALO PLANT

FIGURE III-4
ALTERNATIVE 2

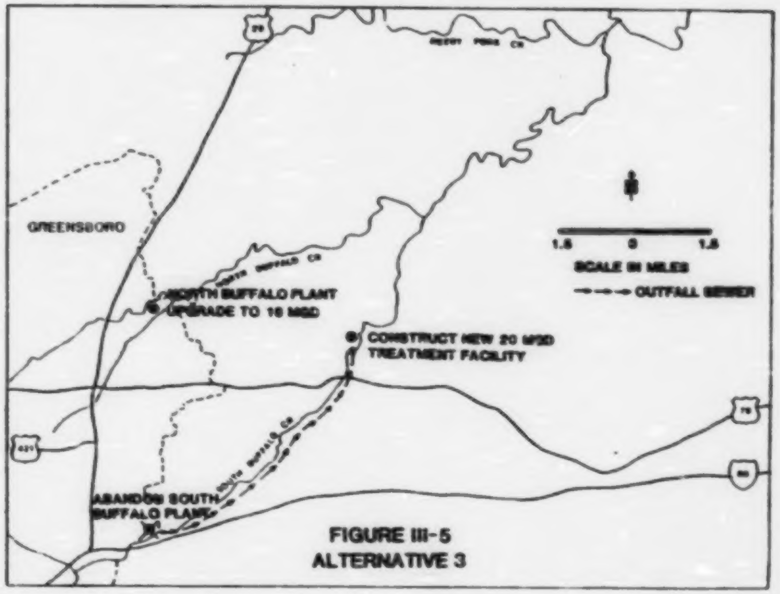

29
REEDY FORK CR
GREENSBORO
1.5
0
1.5
SCALE IN MILES
OUTFALL SEWER
NORTH BUFFALO CR
NORTH BUFFALO PLANT
UPGRADE TO 16 MGD
CONSTRUCT NEW 20 MGD
TREATMENT FACILITY
SOUTH BUFFALO CR
421
70
85
ABANDON SOUTH
BUFFALO PLANT

FIGURE III-5
ALTERNATIVE 3

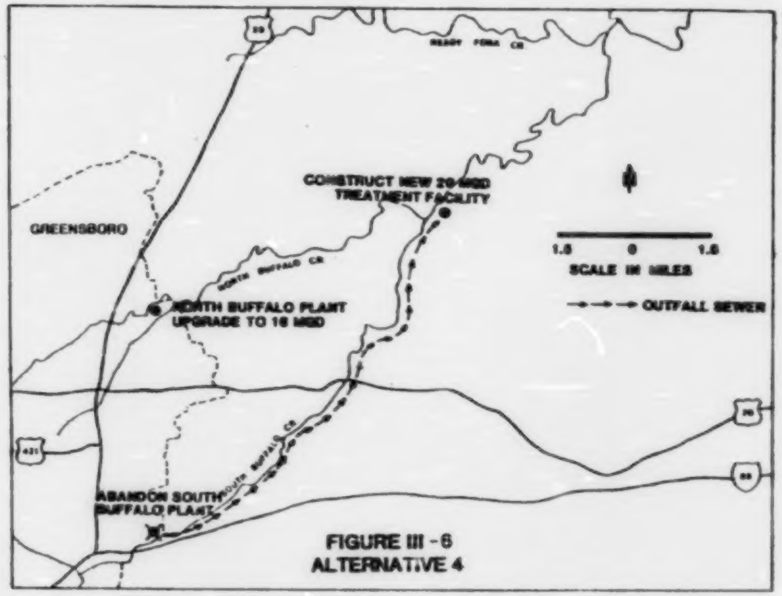
construct an outfall/force main from the existing South Buffalo plant to Highway 70 (Figure III-3).

Alternative 2 - Upgrade the North Buffalo Creek facility to provide a tertiary level of treatment at 16.0 MGD; abandon the existing South Buffalo Creek facility and construct a new tertiary facility approximately 14,000 lineal feet downstream of the abandoned plant; construct an outfall sewer from the existing South Buffalo Creek facility to the new facility downstream; construct an outfall/force main from the new facility to Highway 70 (Figure III-4).

Alternative 3 - Upgrade the North Buffalo Creek facility to provide a tertiary level of treatment at 16.0 MGD; abandon the South Buffalo Creek facility and construct a new tertiary facility approximately 26,000 lineal feet downstream of the abandoned plant; construct an outfall sewer from the existing South Buffalo Creek facility to the new facility downstream (Figure III-5).

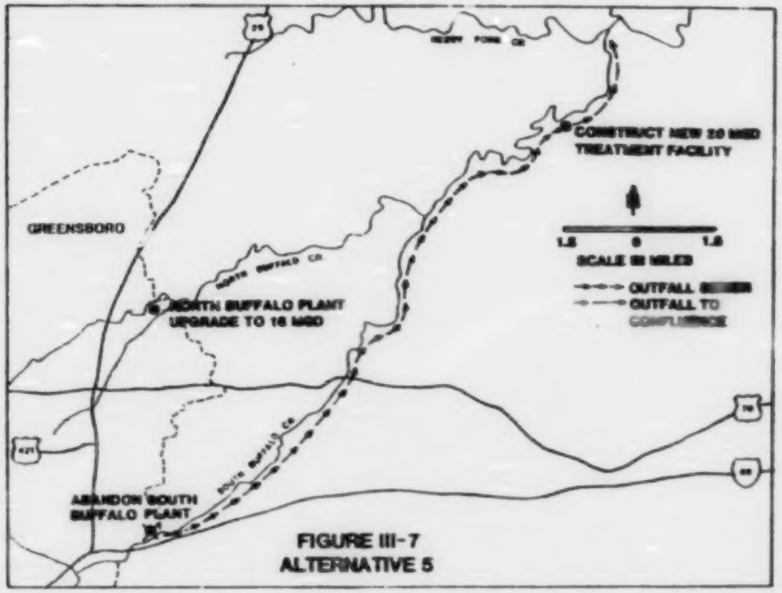
Alternative 4 - Upgrade the North Buffalo Creek facility to provide a tertiary level of treatment at 16.0 MGD; abandon the South Buffalo Creek facility and construct a new tertiary facility approximately 46,500 lineal feet (near confluence of North and South Buffalo Creeks) downstream of the abandoned plant; construct an outfall sewer from the existing South Buffalo Creek facility to the new facility downstream (Figure III-6).

Alternative 5 - Upgrade the North Buffalo Creek facility to provide a tertiary level of treatment at 16.0 MGD; abandon the South Buffalo Creek facility and construct a new tertiary facility approximately 20,000 lineal



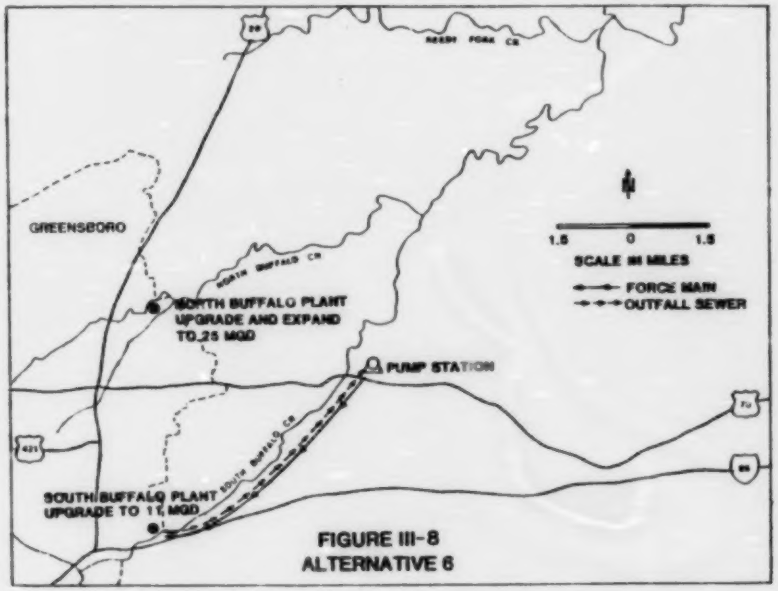
GREENSBORO
READY FORK CR
NORTH BUFFALO CR
SOUTH BUFFALO CR
CONSTRUCT NEW 20 MGD TREATMENT FACILITY
NORTH BUFFALO PLANT UPGRADE TO 16 MGD
ABANDON SOUTH BUFFALO PLANT
1.5 0 1.5
SCALE IN MILES
OUTFALL SEWER
29
421
70
85

FIGURE III -6
ALTERNATIVE 4



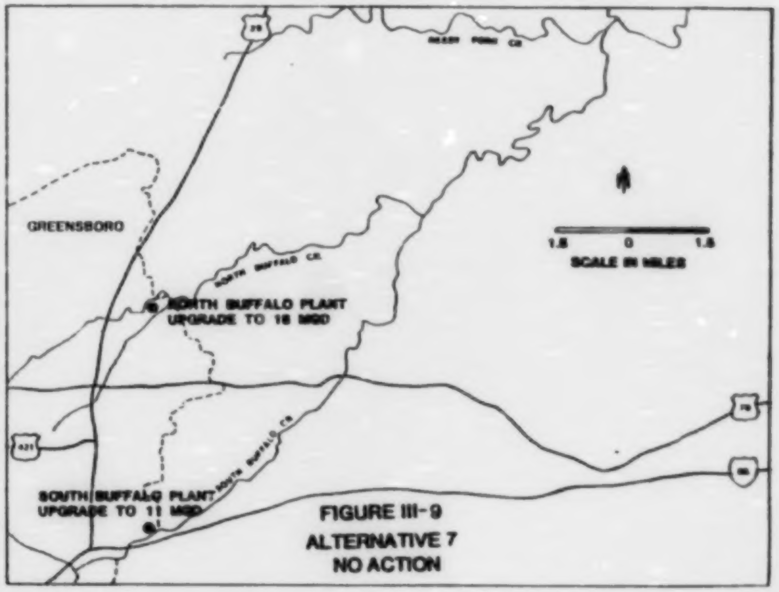
GREENSBORO
READY FORK CR
NORTH BUFFALO CR
SOUTH BUFFALO CR
CONSTRUCT NEW 20 MGD TREATMENT FACILITY
NORTH BUFFALO PLANT UPGRADE TO 16 MGD
ABANDON SOUTH BUFFALO PLANT
1.5 0 1.5
SCALE IN MILES
OUTFALL SEWER
OUTFALL TO CONFLUENCE
29
421
70
85

FIGURE III-7
ALTERNATIVE 5



GREENSBORO
READY FORK CR
NORTH BUFFALO CR
SOUTH BUFFALO CR
NORTH BUFFALO PLANT UPGRADE AND EXPAND TO 25 MGD
PUMP STATION
SOUTH BUFFALO PLANT UPGRADE TO 11 MGD
1.5 0 1.5
SCALE IN MILES
FORCE MAIN
OUTFALL SEWER
29
421
70
85

FIGURE III-8
ALTERNATIVE 6



GREENSBORO
READY FORK CR
NORTH BUFFALO CR
SOUTH BUFFALO CR
NORTH BUFFALO PLANT UPGRADE TO 16 MGD
SOUTH BUFFALO PLANT UPGRADE TO 11 MGD
1.5 0 1.5
SCALE IN MILES
29
421
70
85

FIGURE III-9
ALTERNATIVE 7
NO ACTION

feet downstream of the confluence of North and South Buffalo Creeks; construct an outfall sewer from the existing South Buffalo Creek facility to the new facility downstream and from the new facility to Reedy Fork Creek for ultimate disposal of the treated wastewater (Figure III-7).

Alternative 6 - Upgrade the North Buffalo Creek facility to provide a tertiary level of treatment at 16.0 MGD immediately; upgrade the South Buffalo Creek facility to provide a tertiary level of treatment at 11.0 MGD; expand the North Buffalo Creek tertiary facility to 25 MGD in 1987; provide a pump station and force main to transfer approximately 9.0 MGD from the South Buffalo Creek facility to the expanded North Buffalo Creek facility; construct an outfall/force main from the existing South Buffalo plant to Highway 70 (Figure III-8).

Alternative 7, No Action - Upgrade both the North Buffalo Creek facility and the South Buffalo Creek facility to provide a tertiary level of treatment at the present flow capacity; provide septic tanks to additional households which are not provided sewer service (Figure III-9).

E. Effluent Limitations and Selection of Unit Processes

The level or degree of treatment which must be provided by each treatment facility is dependent on the necessary hydraulic capacity, influent quality and characteristics, and the location and method of discharge. Effluent limitations cannot be assigned to a particular facility until such locations and capacities are identified. Additionally, if more than one facility is located on a single stream or stream system such as North and South Buffalo Creeks, the required quality of effluent discharged from each plant may be interdependent.

Effluent limitations for BOD_5, NH_3-N, and dissolved oxygen are established in the 303(e) Basin Planning Process to attain water quality stream standards for dissolved oxygen. The limits for BOD_5 and NH_3-N are usually specified as maximum monthly mean values. Maximum weekly values, normally 1.5 times the monthly values, are also specified in the affected discharge permits.

There are two basic levels of analysis used to establish effluent limitations which are identified as level "B" or level "C." In each case the analysis can produce an infinite number of combinations of effluent BOD_5, NH_3-N, and dissolved oxygen that will attain water quality standards.

The "B" and "C" levels of analysis differ primarily by the amount of data available. The "C" analysis is based on intensive water quality survey data while the "B" analysis is an empirical analysis based largely on hydrographic factors and past experience. Additional explanation of the "B" and "C" analysis is contained in Appendix E of the basin plan (NO-111).

To determine the effluent limitations for the Greensboro area, a level "C" analysis was performed for all the North and South Buffalo Creek alternatives and a level "B" analysis was performed for the Reedy Fork alternatives. All analyses were based on the extended Streeter-Phelps theory. For discharges to the North Buffalo Creek and to Buffalo Creek down to the confluence with Reedy Fork, the results of an intensive survey completed in 1972 and time of travel studies completed in 1969 and 1973 were used for the model. Waste load allocations were assigned, based on the assimilative capacity of the stream and the effects of all future discharges, and were translated into effluent limitations.

For discharges to South Buffalo Creek, the results of an intensive survey performed in August and September of 1972 were used in the model. However, the effects of other dischargers to the stream were not explicitly incorporated in the model and no true waste load allocations were determined. Therefore, the effluent limitations to South Buffalo Creek are based on the projected discharge from the municipal treatment facility alond and the observed capacity of the creek to assimilate that sole discharge.

Results from the models and the imposed effluent limitations for the City of Greensboro wastewater treatment plant alternatives are provided in Table III-3. It should be noted that these limitations assigned represent the most stringent effluent limitations that the State of North Carolina can legally impose.

To satisfy these effluent limitations, the existing treatment facilities can be improved with the addition of nitrification facilities and multimedia filtration. These unit processes are consistent with the most sophisticated treatment required for the removal of BOD_5, NH_3-N, and TSS. The installation of these facilities represents a maximum attempt at meeting the stringent standards.

New treatment plants designed to provide this necessary level of treatment can include a two-stage aeration system. The first stage is used to satisfy the carbonaceous BOD, whereas the second stage will satisfy the nitrogenous BOD and NH_3-N is removed. This same degree of treatment can be attained with a single-stage system, but the possibility of plant upsets due to substrate toxicity increases and, consequently, reliability decreases. Because of the nature and potential toxicity of the industrial wastewater discharged to the municipal facilities in the study area, a single-stage biological treatment system is not recommended and would probably not receive an NPDES discharge permit.

TABLE III-3

EFFLUENT LIMITATIONS

Alternative	Description	Design Flow (MGD)	BOD Ultimate (mg/ℓ)	BOD_5 (mg/ℓ)	NH_3-N (mg/ℓ)	TSS (mg/ℓ)	Fecal Coliform #/100 mℓ
1	North Buffalo	16	32	6	4	30	1000
	South Buffalo (Existing)	20	39	11	5	30	1000
2	North Buffalo	16	32	6	4	30	1000
	New South Buffalo (14,000 L.F. downstream)	20	39	11	5	30	1000
3	North Buffalo	16	32	6	4	30	1000
	New South Buffalo (26,000 L.F. downstream)	20	39	11	5	30	1000
4	North Buffalo	16	32	6	4	30	1000
	Confluence Site	20	28	6	3	30	1000
5	North Buffalo	16	32	6	4	30	1000
	Buffalo	20	42	18	6	30	1000
6	Phase I:						
	North Buffalo	16	38	6	4	30	1000
	South Buffalo (Existing)	11	52	14	7	30	1000
	Phase II:						
	North Buffalo	25	28	6	3	30	1000
	South Buffalo (Existing)	11	52	14	7	30	1000
7	No Action:						
	North Buffalo (Existing)	18	32	6	4	30	1000
	South Buffalo (Existing)	11	52	14	7	30	1000

Additional facilities for a new treatment plant can include primary clarification before the two-stage aeration facilities, final clarification, filtration, and disinfection. The construction of these facilities will also represent a maximum attempt to attain the imposed effluent limitations.

F. Evaluation of Alternatives

The evaluation of the environmental impacts and the economic costs of the system alternatives is summarized in this section. A more detailed account of the evaluations is included in the Technical Reference Document (RA-R-406). In this section the methodology utilized in the evaluation is reviewed first and is followed by presentation of the results. A final subsection gives the conclusions based on the analysis of the alternatives.

1. General Methodology

The methodology for evaluating alternatives was the development of independent rankings of costs, using various measures of economic effectiveness, and of environmental impact, gaged from the superposition of the various treatment systems, described in this chapter, on the environment of the study area, as described in Chapter II, Existing Environment.

a. Environmental Rankings

A multilevel environmental assessment of the 124 identified alternatives was performed to incorporate environmental factors into the alternative selection process. The levels of analysis included the following steps:

1. Identification of sensitive environmental areas and issues as related to each of the sites comprising the 124 alternatives

2. Through cost, implementability and environmental tradeoff factors, twelve alternatives were selected for more detailed review

3. From these twelve, six alternatives plus No Action were chosen by EPA and North Carolina Department of Natural and Economic Resources for detailed environmental assessment.

The Greensboro EIS Advisory Committee (see Chapter VII) was convened and inputs were obtained during development of the six alternatives for detailed assessment.

The six alternatives plus No Action were evaluated for environmental impact using a systematic, comprehensive approach. The basic approach for each alternative evaluation was to generate a Figure of Merit (FOM) based on (1) the relative importance of various specific environmental categories as perceived by the Greensboro EIS Advisory Committee, and (2) an objective enumeration of adverse impacts of components by an unbiased, multidisciplinary professional group using environmental criteria with a one-to-one correspondence to the citizen's environmental categories. The environmental criteria and categories employed in the evaluation system and their correspondence are shown in Table III-4. The evaluation process is one of the minimizing adverse impacts, unmitigated by other measures, rather than optimizing the mix of beneficial and adverse impacts. The FOM rating is supplemented by a listing of "Red Flags," or major adverse impacts and "Green Flags," substantial benefical impacts other than the lack of "adverse" impacts. The details of the environmental evaluation system are presented in the Technical Reference Document (RA-R-406).

TABLE III-4

ENVIRONMENTAL CRITERIA ADOPTED IN ALTERNATIVES EVALUATION PROCESS

Natural Environment	Man-Made Environment
Air Quality	Existing Land Uses
Noise	Future Industrial Land Use
Odor	Future Residential Land Use
Water Quality of Streams	Future Agricultural Land Use
Water Quality of Lakes	Other Future Land Uses
Streamflow and Surface Water Quality	Transportation System
Ground Water Quality	Community Services and Facilities
Ground Water Flow	Ongoing Projects and Programs
Terrestrial Fauna	Cultural Resources
Aquatic Biota	Taxes and Budgeting
Biologically Sensitive Areas	
Substrate Suitability of Projected Uses	

b. Cost Rankings

The costs for each of the unit processes for the wastewater treatment facilities were estimated using information sources that are in general use for this purpose (ST-352; VA-123) and current construction and operation and maintenance costs as designated by North Carolina Department of Natural and Economic Resources. Wastewater treatment plant design for cost estimates was based on effluent limitations as imposed by the State of North Carolina.

In accordance with good engineering design practices, maximum use of existing unit processes was assumed for systems utilizing existing wastewater treatment facilities. Primary clarification, two-stage aeration, final clarification, multimedia filtration, and disinfection formed the basis for estimating the cost of new wastewater treatment facilities. Biological sludges were considered to be dewatered with vacuum filters and incinerated with ultimate disposal of ash at the existing landfill site. A small portion of the sludges at the North Buffalo plant will be anaerobically digested to maintain the existing digesters for back-up capability. At the South Buffalo plant, sludges were assumed to be stabilized in the existing anaerobic digesters and dewatered by vacuum filters. Phosphorus and nitrogen removal were not included in the design basis for any alternative system since nutrient removal is not specified by the design effluent limitations.

2. Results

The rankings produced by the environmental and economic evaluations of the alternatives are presented in the following subsections.

a. Environmental Rankings

The Greensboro EIS Advisory Committee was provided materials on meaning for each of the environmental categories in Table III-4. Education and information sessions were also held to provide additional understanding of their relationships to the Greensboro area. A detailed version of Chapter II was prepared for revies by the Greensboro EIS Advisory Committee to add to their understanding of the elements of the environment as they now exist.

After this educational process, each member was asked to judge the importance of each environmental category relative to the others to the Greensboro area environment. The values were normalized, averaged, and squared to reduce citizens responses to a single weighting function for each category (RA-R-406).

The categories have been arranged in order of perceived importance in Table III-5. Two categories, protection of water quality of area streams and protection of water quality of area lakes were judged to be the most important, with a weighting value of 1.42. Closely following were concern for maintenance of air quality with a weighting value of 1.27. Other categories ranged from 1.13 for ground water flow down to .70 for terrestrial fauna and cultural resources.

For technical evaluation of the impact upon each environmental category, a multidisciplinary professional jury was assembled. Assessments were made for each major component of each candidate alternative. A total of 22 components were evaluated and then appropriate components were combined to comprise the systems under study. A detailed description of the components are contained in the Technical Reference Document (RA-R-406) and are summarized in Table III-6 with the resulting degree of relative adverse impact for each alternative. The range of adverse impacts is from a low of 0.612 for upgrading North Buffalo plant to a high of 7.333 for No Action. The component impact values were processed with the environmental evaluation system to ascertain the more environmentally acceptable alternatives. These are presented according to environmental rank as FOM's in Table III-7.

Alternative 6 was determined to be the most environmentally acceptable of the final six alternatives submitted for detailed evaluation. Alternatives 1, 2, and 3 were found to be essentially equivalent in environmental acceptability. FOM's of 6.230, 6.242, and 6.362 were computed for Alternatives 3, 2, and 1, respectively.

An additional set of factors was considered in the evaluation process. Some impacts were considered to be of sufficient severity to be flagged as particularly important. These impacts

TABLE III-5

ORDER OF IMPORTANCE OF ENVIRONMENTAL CATEGORIES AS JUDGED BY GREENSBORO CITIZENS REVIEW GROUP

Weighting Factor	Natural Environment	Man-Made Environment	Category
1.42	1		Water Quality of Streams
1.42	1		Water Quality of Lakes
1.27	2		Air Quality
1.27	2		Ground Water Quality
1.13	3		Streamflow and Surface Water Quality
1.12	4		Ground Water Flow
1.07	5		Odor
1.00	6		Biologically Sensitive Areas
1.00		6	Existing Land Use
.99		7	Future Industrial Land Use
.99		7	Future Residential Land Use
.95		8	Taxes and Budgeting
.90		9	Resource Use Patterns
.88	10		Natural Vegetation
.85		11	Future Agricultural Land Use
.85		11	Other Future Land Uses
.83		12	Community Services and Facilities
.82	13		Aquatic Biota
.82		13	Transportation System
.80		14	Ongoing Projects and Programs
.78	15		Noise
.77	16		Substrate Suitability for Projected Uses
.70	17		Terrestrial Fauna
.70		17	Cultural Resources

TABLE III-6

ALTERNATIVES SYSTEM COMPONENTS ENVIRONMENTALLY EVALUATED BY MULTIDISCIPLINARY PROFESSIONAL JURY AND RESULTING RELATIVE IMPACTS

Component Number	Component Description	Component Contained in System Number	Relative Degree of Adverse Impact
1	Upgrade NBP* to 16 MGD	1, 2, 3, 4, 5, 6	0.612
2	Expand NBP to 25 MGD in 1987	6	1.381
3	Upgrade SBP* to 11 MGD	6	0.905
4	Upgrade and expand SBP to 20 MGD	1	1.771
5	**New 20 MGD plant on SB at Site 4	2	2.826
6	New 20 MGD plant on SB at Site 5	3	2.873
7	New 20 MGD plant on SB at Site 6	4	3.015
8	New 20 MGD plant on Buffalo at Site 7	5	3.675
9	Outfall sewer from SBP to Site 4	2	2.447
10	Outfall sewer from SBP to Site 5	3	2.447
11	Outfall sewer from SBP to Site 6	4	4.238
12	Outfall sewer from SBP to Site 7	5	4.608
13	Outfall sewer from Site 7 to Reedy Fork	5	3.013
14	Outfall/force main from SBP to Hwy 70	1, 2, 6	2.447
15	Force main from SBP to NBP	6	1.743
***16	Alternative System Number 1	1	1.719
17	Alternative System Number 2	2	1.146
18	Alternative System Number 3	3	1.146
19	Alternative System Number 4	4	0.784
20	Alternative System Number 5	5	0.625
21	Alternative System Number 6	6	1.716
22	No Action Alternative		7.333

*NBP = Existing North Buffalo Treatment Plant
SBP = Existing South Buffalo Treatment Plant

**For new site locations refer to Figure III-1

***Those environmental categories that could not be assessed at the component level were evaluated at the system level.

TABLE III-7

ENVIRONMENTAL RANKING OF SYSTEM ALTERNATIVES

Environmental Rank	FOM Value*	System Alternative
1	7.533	6
2	6.278**	1,2,3
3	5.837	4
4	5.490	5
5	0.667	7

*Higher numbers are more environmentally acceptable
**Average FOM for Alternatives 1, 2, 3

are not reflected equitably in the environmental evaluation system and were studied separately. For each environmental category receiving such an evaluation, a "Red Flag" was assigned. Table III-8 lists the categories receiving red flags and corresponding alternative systems.

The presence of a red flag may in itself cause a particular alternative to be eliminated from further consideration depending upon its significance, regardless of how the alternative ranked in the FOM evaluation. For example, Alternative 2, although ranking the second environmental category was red flagged because it contains a century-old highly productive family farm on the site considered for construction of a new wastewater treatment plant. Guidelines from the President's Council on Environmental Quality discourage removing prime agricultural land from productivity if other alternatives will provide accommodation of the project needs.

Additional factors that influenced the evaluation process were social in nature. After careful consideration of all factors involved in the selection process (cost, environmental, engineering, and implementability), the EPA Administrator of Region IV determined that the continued existence of the South Buffalo plant

TABLE III-8

ENVIRONMENTAL CATEGORIES AND SYSTEMS RECEIVING RED FLAGS DURING ALTERNATIVES ENVIRONMENTAL EVALUATION

Environmental Category	Component	Alternative System
Air Quality	No Action	No Action
Noise	15	6
Water Quality of Streams	No Action	No Action
Water Quality of Lakes	No Action	No Action
Streamflow and Surface Water Quality	No Action	No Action
Natural Vegetation	9,10,11,12,13,14	1,2,3,4,5
Aquatic Biota	13, No Action	5, No Action
Substrate Suitability	No Action	No Action
Existing Land Use	4, No Action	1, No Action
Future Industrial Land Use	No Action	No Action
Future Residential Land Use	No Action	No Action
Future Agricultural Land Use	4,5,7,No Action	1,2,4,No Action
Transportation System	15, No Action	6, No Action
Community Services and Facilities	No Action	No Action
Ongoing Projects and Programs	No Action	No Action
Resource Use Patterns	No Action	No Action

was not socially acceptable in any alternative. This decision was based upon the history of odor problems with the plant and the large number of people that had been adversely affected by this pollutant (RA-R-406).

Consequently, with elimination of the existing South Buffalo site, the number of alternatives was reduced from seven to five, alternatives 2, 3, 4, 5, and No Action. With Alternative

2 containing the highly productive farm land, the surviving alternatives from which the proposed action was selected were 3, 4, 5, and No Action.

b. Cost Rankings

Detailed cost estimates for each system alternative including capital costs and operation and maintenance costs are provided in a supplementary cost document to this EIS. The cost estimates reported are not necessarily the final cost estimates for construction of the facilities. The final estimates will be determined by the design engineering contractor and will reflect current equipment and construction costs at the time of construction. The cost estimates contained herein do approximate the expected costs and provide a sound basis for a confident cost evaluation and comparison.

The cost summary and comparison of system alternatives are provided in Table III-9. Total capital costs are amortized over a 20-year period at an interest rate of 6-3/8 percent and are added to the respective total annual operation and maintenance costs to determine total annual cost. Total annual operation and maintenance costs are based on a design flow of 36.0 MGD. Additionally, the total treatment cost of each system alternative is provided to facilitate economic ranking. For the No Action alternative, costs were based on upgrading the existing facilities to meet the proposed effluent limitations and providing additional required service with septic tanks.

Table III-10 provides a present worth cost ranking and the associated user's costs for the seven alternatives including the No Action alternative. Assumptions for the present worth analysis include an interest rate of 6-3/8 percent, a useful life of 30 years for all structures except incinerators, 20 years for

TABLE III-9

COST SUMMARY AND COMPARISON OF SYSTEM ALTERNATIVES

SYSTEM ALTERNATIVES	CAPITAL COSTS (\$)(10^6)	AMORITIZED[1] CAPITAL COSTS (\$/YR)(10^6)	O&M COST[2] (\$/YR)(10^6)	TOTAL ANNUAL COST (\$/YR)(10^6)	TOTAL TREATMENT COST (\$/MG)
1	21.665	1.917	3.000	4.947	380
2	31.665	2.845	2.441	5.286	400
3	33.345	2.996	2.447	5.443	410
4	36.215	3.254	2.437	5.691	430
5	43.705	3.927	2.439	6.366	480
6	21.226	1.907	2.585	4.492	340
7 - No Action	26.902	2.384	2.450	4.834	370

[1] Based on 20 years @ 6-3/8% interest for WWTP's and 30 years @ 8% for septic tanks.

[2] Based on design flow of 36.0 MGD.

TABLE III-10

PRESENT WORTH AND USER'S COSTS OF SYSTEM ALTERNATIVES

SYSTEM ALTERNATIVE	PRESENT WORTH MILLION $ x 10^6	ANNUAL USER'S COST ($/HOUSEHOLD/YR)
1	52.853	42.70
2	55.760	36.30
3	57.207	36.60
4	59.223	36.90
5	65.431	38.20
6	48.867	36.60
7 - No Action	53.407	48.70

incinerators, 50 years for all piping, and a design period of 20 years. Land is assumed not to depreciate. User's cost is based on the total local capital costs and municipal operation and maintenance costs for a sewered population of 255,000.

3. Other Evaluation Criteria

Other criteria for ranking or evaluating the selected alternatives include implementability, reliability, and resource utilization. These criteria are considered as secondary information for selection of the proposed action.

a. Implementability

All six alternatives under investigation can be implemented considering engineering and construction factors. However, further expansion of proposed systems at existing plant sites will require special considerations. The North Buffalo Creek plant would be the more difficult to expand owing to the limited acreage on which the existing facilities are located. Any proposed expansion would necessarily be located across the North Buffalo Creek, nearer the shopping center and additional flood protection would be required. The expansion of the South Buffalo plant would require the acquisition of A & T University land and additional flood protection would be required as well as possible additional channelization of South Buffalo Creek. However, sufficient acreage does exist and no other significant engineering constraints which would limit the implementability of this expansion are apparent. Land availability for the new treatment plant sites is more than sufficient and no foreseeable technical problems exist at any of these sites.

Public opposition to all of the alternatives has been expressed from various groups. This observation is well-documented in public hearings held concerning this project and is confirmed with the associated public involvement. It is doubtful whether any alternative selected will receive full public acceptance, and any ranking based on implementability would be subject to serious question.

b. Reliability

The design and construction of new wastewater treatment facilities which incorporate recent technology and treatment methods will offer more reliability and performance than improvement and/or expansion of existing facilities. The efficiency of the existing trickling filters at both plants is temperature-dependent and in cool weather these filters provide little treatment. Additionally, the existing facilities offer little resistance to the occasional occurrence of industrial toxic loadings. In the future, the city will mitigate the potential for these occurrences by requiring adequate pre-treatment of wastewater entering the municipal plants.

The proposed two-stage biological system for new plants is less temperature-dependent and is less susceptible to plant upset related to toxic loadings. The possibilities for consistent attainment of the imposed stringent effluent limitations is much greater with the new facility than with improved existing facilities. Therefore, alternatives which incorporate the use of a new treatment facility will provide a greater degree of reliability and performance than alternatives which utilized expanded existing facilities.

c. Resource Utilization

Resources required for the construction and operation of the treatment plant improvements are relatively small compared to the total resource use in the study area. While plant site energy consumption for pumps, blowers, and sludge incinerators is high, the treatment service is necessary and will impose only very slight incremental demand on local utilities. Since resource requirements for all of the alternatives have been judged to be of only minor significance, the utility of a differential resource use ranking is questionable and would probably be misleading. Thus, it was not an appreciable factor in this selection process.

G. Conclusions

After careful review of the environmental and economic evaluations, system Alternative 3 was selected as the proposed action for the Draft EIS. This alternative recommends upgrading the North Buffalo Creek treatment plant at 16.0 MGD and construction of a new 20.0 MGD facility approximately 26,000 lineal feet downstream of the existing South Buffalo Creek plant which will be abandoned. This alternative will provide the necessary service, including capacity and level of treatment, to satisfy both the municipal and industrial demands of the study area throughout the design period.

IV. DESCRIPTION OF PROPOSED ACTION

The proposed action for wastewater treatment facilities' improvements for the City of Greensboro, includes maintaining and upgrading the existing North Buffalo treatment plant at 16.0 MGD and construction of a new 20.0 MGD facility approximately 26,000 lineal feet downstream of the existing South Buffalo Creek facility. A new sixty-inch, 26,000-foot outfall from the existing South Buffalo to the new facility will also be constructed. The South Buffalo Creek plant will be abandoned and dismantled and the existing city-owned site will become available for other desired uses. Figure IV-1 shows the location and size of the proposed facilities with respect to the City of Greensboro.

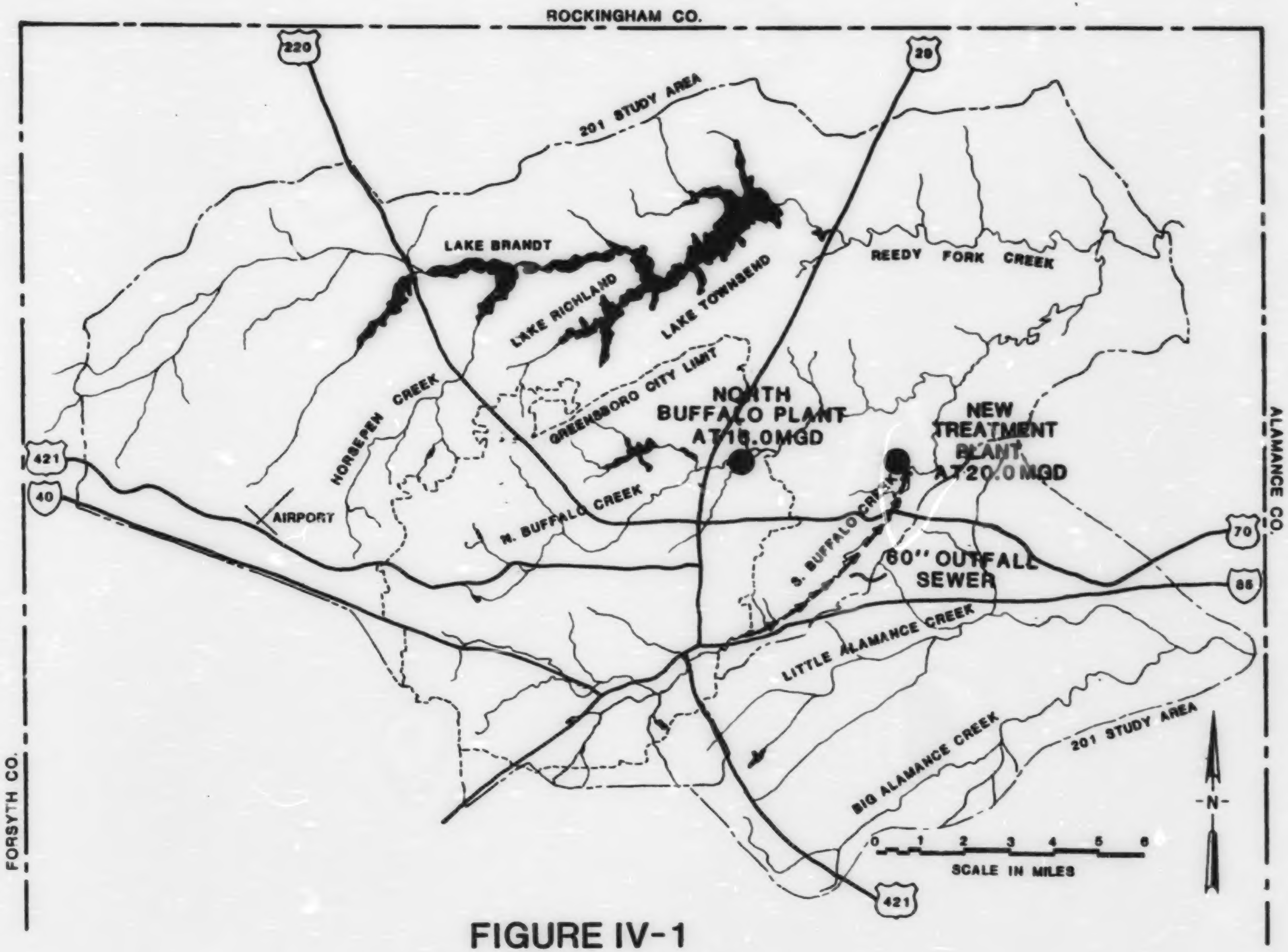
A. Description of Proposed Facilities

All advanced wastewater treatment plants constructed in the State of North Carolina are required to meet the Reliability Class I criteria as outlined in EPA-430-99-29-001 (EN-610). All processes described herein will be designed using that criteria.

1. Existing North Buffalo Facility

The existing North Buffalo treatment plant provides facilities for preliminary treatment, primary treatment, secondary treatment, and chlorination. Primary and waste-activated sludge is thickened and dewatered with vacuum filters before incineration and ultimate disposal in the nearby landfill site.

To meet the imposed stringent effluent limitations, this facility can be upgraded by improving or modifying selected existing unit processes as well as constructing new additional processes. The following description of possible improvements



ROCKINGHAM CO.
ALAMANCE CO.
FORSYTH CO.
220
29
421
40
70
85
201 STUDY AREA
LAKE BRANDT
LAKE RICHLAND
LAKE TOWNSEND
REEDY FORK CREEK
GREENSBORO CITY LIMIT
HORSEPEN CREEK
AIRPORT
N. BUFFALO CREEK
NORTH BUFFALO PLANT AT 16.0MGD
NEW TREATMENT PLANT AT 20.0 MGD
S. BUFFALO CREEK
60'' OUTFALL SEWER
LITTLE ALAMANCE CREEK
BIG ALAMANCE CREEK
201 STUDY AREA
0 1 2 3 4 5 6
SCALE IN MILES
-N-

FIGURE IV-1
PROPOSED ACTION

and additions includes a brief inventory of existing unit processes. This approach will place the recommended proposed action into perspective for reviewing purposes.

The existing preliminary treatment facilities include a bar rack and screen, grit collector, and flow meter. These facilities were originally designed for a capacity of 18.0 MGD and should be sufficient for the proposed 16.0 MGD design capacity.

The existing primary treatment facilities include four identical rectangular clarifiers. Each clarifier is 80 feet long, 40 feet wide, and 15 feet deep. With a total surface area of 12,800 square feet, the design overflow rate at 16.0 MGD would be approximately 1,250 gpd/ft^2. This overflow rate is slightly higher than the state recommended rate of 1,000 gpd/ft^2, but can be considered marginal if the overall necessary level of treatment can be attained.

Effluent from the primary clarifiers is lifted to trickling filters. The existing lift station has a pumping capacity of 18.0 MGD (average) and should be sufficient for the proposed 16.0 MGD facility. Therefore, no additional intermediate pumping facilities are recommended.

The existing trickling filter facilities include two identical units with diameters of 200 feet and depths of 4 feet. These facilities have a total surface area of 62,800 square feet (1.44 acres) and a total volume of 251,200 cubic feet, and are operated with 100 percent recirculation. Assuming a BOD_5 removal efficiency of 20 percent, and continued 100 percent recirculation, the total organic loading on the trickling filters at 16.0 MGD is 8,330 pounds/acre-feet/day. This loading is extremely high and modifications are necessary if these facilities are to continue being used as roughing filters. Possible modifications can include increasing the filter depth and volume, replacement of the existing media with a plastic media, and reduction in recirculation.

The existing aeration tank facilities include four identical rectangular units each with a length of 261 feet, width of 42 feet, and a depth of 13 feet. With a total volume of 570,000 cubic feet, these facilities will provide a detention time of approximately 6.4 hours at 16.0 MGD. This detention time should be sufficient to provide nitrification if adequate aeration is provided without excess mixing.

The existing aeration facilities provide a blower capacity of approximately 14,000 cfm. Assuming an oxygen requirement of 1.5 pounds per pound of BOD_5 removed and 4.6 pounds per pound of ammonia-nitrogen (NH_3-N) removed, additional blower capacity of 7,000 cfm for a total of 21,000 cfm is necessary to satisfy the effluent limitations. This aeration will provide a mixing capability of 37 cfm per 1,000 cubic feet of aeration basins which is slightly high but marginally acceptable.

Existing final clarifiers include five circular tanks; two with diameters of 75 feet and depths of 16 feet, two with diameters of 90 feet and depths of 15 feet, and one with a diameter of 75 feet and depth of 13 feet. At a design flow of 16.0 MGD, the total surface area of 25,960 square feet will provide an overflow rate of 620 gpd/ft^2. With a total volume of 389,460 cubic feet, the average hydraulic detention time will be approximately 4.4 hours. These parameters are well within the acceptable limits and no additional final clarifiers are required.

The North Buffalo Creek facility does not have facilities providing multimedia filtration. To achieve and maintain the BOD_5 limitation of 6 mg/ℓ, it is necessary that additional treatment be provided. The use of multimedia filters after nitrification would represent a cost-effective maximum attempt for achieving the stringent limitations. As recommended by the State of North Carolina, municipal multimedia filters should have a design hydraulic loading of no more than 3 gpm/ft^2. This loading rate will require a total surface area of approximately 3,700 square feet.

In addition to the multimedia filters, an intermediate lift station will probably be necessary for loading the filters. This pump station should have a capacity to lift the design flow of 16.0 MGD.

For adequate disinfection, the State of North Carolina requires a minimum detention time of 30 minutes for average flow conditions. To provide this detention time for 16.0 MGD, a tank size of approximately 44,560 cubic feet is required. The existing contact chamber has a volume of 35,625 cubic feet and an additional volume of approximately 9,000 cubic feet must be provided to satisfy regulations. However, if the new multimedia filters are placed downstream of the chlorination facilities, additional chlorine contact time in the filters may be sufficient for adequate disinfection. This proposed action is not necessarily recommended but only suggested for consideration. Any such variance will require the review and approval of both state and federal agencies.

With the existing North Buffalo facilities and possible modifications discussed herein, the North Buffalo Creek plant should provide adequate treatment for 16.0 MGD and produce a water quality acceptable for discharge into North Buffalo Creek.

However, presently unforeseen problems may exist, and additional treatment may become necessary once this facility is on-line and operating properly.

Primary and waste-activated sludge at the North Buffalo Creek plant is thickened, dewatered with vacuum filters, and incinerated. Ash is disposed of at the nearby landfill site. Additionally, a two-stage anaerobic digestion facility is available but is used only as a backup to the sludge handling facilities described. Stabilized sludge is dewatered with the vacuum filters and disposed of at the existing landfill site.

The existing primary sludge thickener has a diameter of 60 feet and a depth of 8 feet providing a surface area of 2,830 square feet and a volume of 22,640 cubic feet. Based on a solids loading rate of 10 pounds/square foot/day, the primary sludge thickener has the capacity to process approximately 14.2 tons of sludge/day. With an estimated primary sludge production of only 3.5 tons/day at 16.0 MGD, the existing primary sludge thickener should be sufficient.

The existing waste-activated sludge floatation thickener has a total surface area of 100 square feet. Based on a solids loading rate of 30 pounds/square foot/day, the flotation thickener can process approximatley 1.5 tons of sludge/day. With an estimated waste-activated sludge production of approximately 6 tons/day, an additional surface area of approximately 300 square feet is necessary.

The existing vacuum filters include two identical units with a surface area of 360 square feet each. Assuming a filter yield of 3.5 pounds/square foot/hour and 56 hours of operation per week, the existing facilities have adequate capacity. However, it is recommended that an additional identical (360 square foot) unit be provided to allow for inevitable downtime.

The existing sludge incinerator has a capacity of two to three tons per hour and need only operate four hours per day to process all of the sludge produced. Therefore, no additional incineration capacity is necessary. This incinerator is currently fueled with natural gas and no associated air pollution has been observed. However, with dwindling supplies of natural gas, it may become more economical to switch to fuel oil at a later date.

Electrical costs to operate the improved North Buffalo facility will approach approximately $300,000 per year at 16.0 MGD. This cost represents an equivalent electrical annual consumption of approximately 8,500 megawatt hours, less than 0.5 percent of the electrical consumption of Greensboro.

With the exception of a masking agent for odor control, the only chemicals used at the North Buffalo Creek plant is chlorine for disinfection. At the design flow of 16.0 MGD, approximately 200 tons of chlorine will be required annually at a cost of approximately $36,000

Construction of the North Buffalo Creek facility improvements will be limited to the present site boundaries and no additional land should be required. Future expansion or improvements will be difficult owing to the limited acreage and, if required, will necessarily be provided across the North Buffalo Creek. All proposed improvements and construction should be complete within 12 to 18 months after construction begins but may vary depending on available materials and time required for deliveries.

A schematic of the proposed North Buffalo Creek plant and improvements and the projected pollutant removal or mass balance for each level of treatment is shown in Figure IV-2. Figure IV-3 shows a possible layout of the actual proposed facilities. However, other possibilities exist and this proposed layout and improvements should in no way constrain the design engineers.

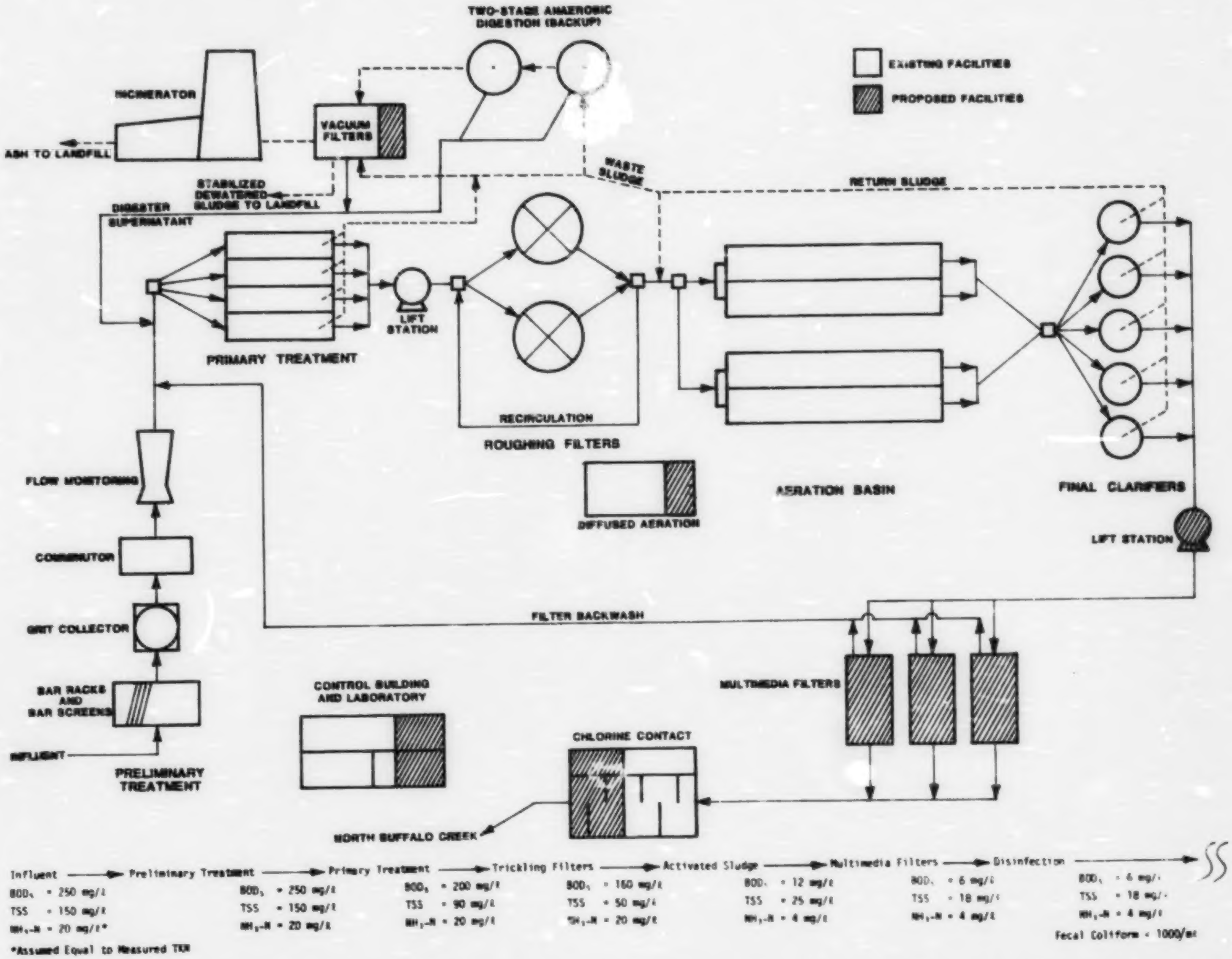

TWO-STAGE ANAEROBIC DIGESTION (BACKUP)
EXISTING FACILITIES
PROPOSED FACILITIES
INCINERATOR
ASH TO LANDFILL
VACUUM FILTERS
WASTE SLUDGE
RETURN SLUDGE
STABILIZED DEWATERED SLUDGE TO LANDFILL
DIGESTER SUPERNATANT
PRIMARY TREATMENT
LIFT STATION
RECIRCULATION
ROUGHING FILTERS
DIFFUSED AERATION
AERATION BASIN
FINAL CLARIFIERS
LIFT STATION
FLOW MONITORING
COMMINUTOR
GRIT COLLECTOR
FILTER BACKWASH
BAR RACKS AND BAR SCREENS
INFLUENT
PRELIMINARY TREATMENT
CONTROL BUILDING AND LABORATORY
CHLORINE CONTACT
MULTIMEDIA FILTERS
NORTH BUFFALO CREEK
Influent → Preliminary Treatment → Primary Treatment → Trickling Filters → Activated Sludge → Multimedia Filters → Disinfection →
BOD_5 = 250 mg/ℓ
TSS = 150 mg/ℓ
NH_3-N = 20 mg/ℓ*
BOD_5 = 250 mg/ℓ
TSS = 150 mg/ℓ
NH_3-N = 20 mg/ℓ
BOD_5 = 200 mg/ℓ
TSS = 90 mg/ℓ
NH_3-N = 20 mg/ℓ
BOD_5 = 160 mg/ℓ
TSS = 50 mg/ℓ
NH_3-N = 20 mg/ℓ
BOD_5 = 12 mg/ℓ
TSS = 25 mg/ℓ
NH_3-N = 4 mg/ℓ
BOD_5 = 6 mg/ℓ
TSS = 18 mg/ℓ
NH_3-N = 4 mg/ℓ
BOD_5 = 6 mg/ℓ
TSS = 18 mg/ℓ
NH_3-N = 4 mg/ℓ
Fecal Coliform < 1000/ml
*Assumed Equal to Measured TKN

FIGURE IV-2 SCHEMATIC OF PROPOSED NORTH BUFFALO CREEK FACILITY WITH IMPROVEMENTS

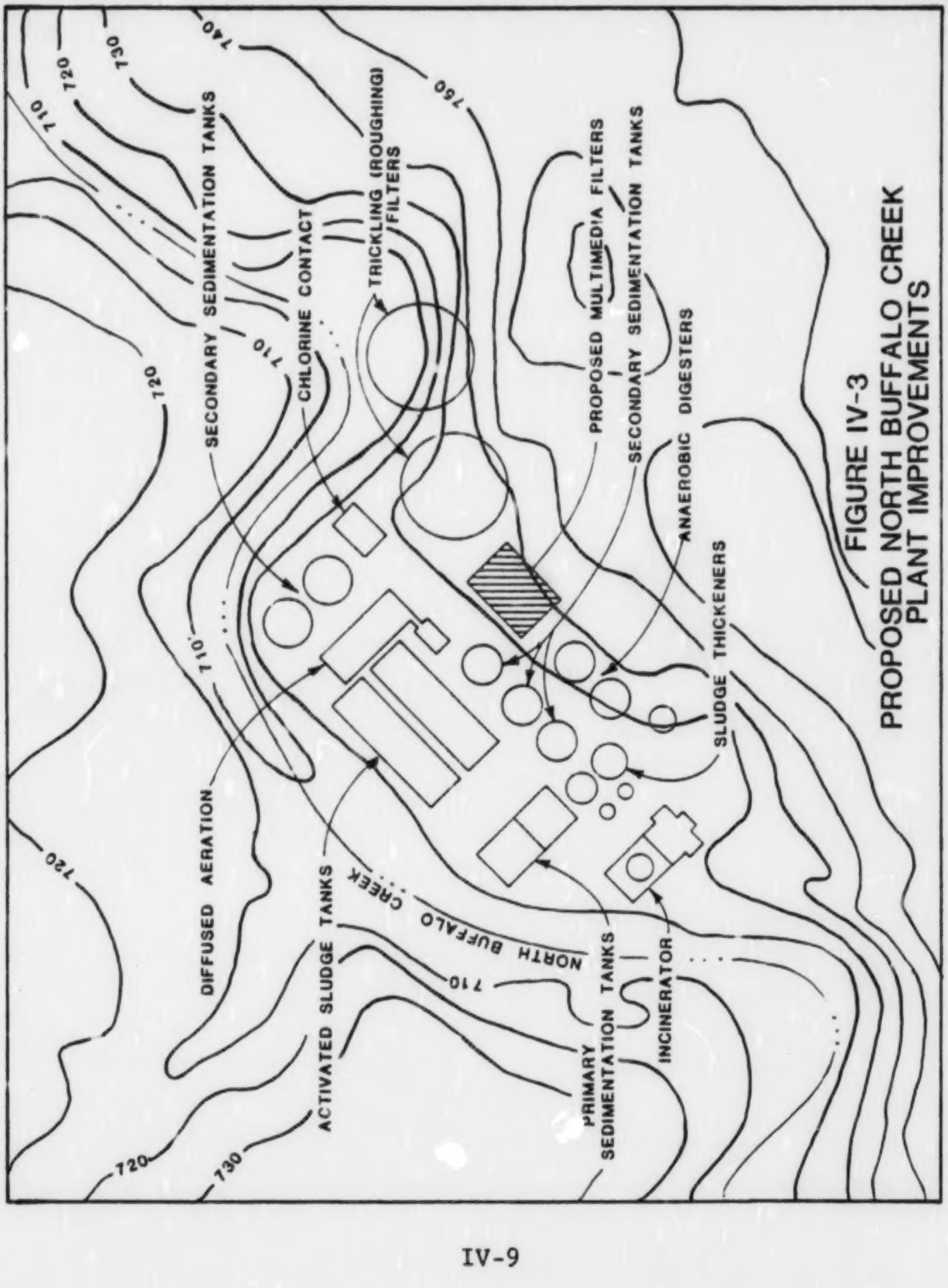

SECONDARY SEDIMENTATION TANKS
CHLORINE CONTACT
TRICKLING (ROUGHING) FILTERS
PROPOSED MULTIMEDIA FILTERS
SECONDARY SEDIMENTATION TANKS
ANAEROBIC DIGESTERS
SLUDGE THICKENERS
DIFFUSED AERATION
ACTIVATED SLUDGE TANKS
PRIMARY SEDIMENTATION TANKS
INCINERATOR
NORTH BUFFALO CREEK
710
720
730
740
750

FIGURE IV-3
PROPOSED NORTH BUFFALO CREEK
PLANT IMPROVEMENTS

The North Buffalo Creek facility currently employs 24 personnel for operation and maintenance. With the recommended improvements, an additional 16 employees will be necessary to properly operate this plant in an attempt to meet effluent limitations. This facility should be staffed with approximately twenty-five personnel on weekdays, five on weeknights, and ten on weekends. The complete staff of forty personnel should include two for supervisory, one for clerical, twenty-one for operations, ten for maintenance, three for laboratory, and three for yardwork.

2. New South Buffalo Facility

The proposed new 20.0 MGD South Buffalo Creek facility will provide raw waste pumping, preliminary treatment, primary treatment, two-stage aeration for nitrification, multimedia filtration, and chlorination. Primary and waste-activated sludge will be thickened, dewatered, and incinerated before ultimate disposal in the existing landfill site. This existing landfill site has a design life of approximately 12 years, but with the addition of a proposed pulverizer, the life will be extended to approximately 20 years. Therefore, this existing site should be sufficient throughout the design period.

Because this new facility will be located above the one-hundred year floodplain, a raw waste pumping station will be required to lift the raw waste from the end of the proposed new sixty-inch outfall. This pump station will be located in the floodplain and will require flood protection. The pump should be designed for peak pumping capacity of approximately 40 MGD.

The preliminary treatment facilities will include bar racks and screens, a comminutor, grit collector, and flow measuring device. These facilities will also be designed for a peak capacity of 40 MGD.

Primary clarifiers will be constructed to provide an overflow rate of 1,000 gpd/ft^2 at 20.0 MGD. This design criteria will require a total primary clarifier surface area of 20,000 square feet. These facilities may be either circular or rectangular in shape. A minimum of three parallel facilities should be provided in the design.

Primary sedimentation will be followed by two-stage biological oxidation with clarification following each stage. The first stage will satisfy the carbonaceous biochemical oxygen demand (CBOD), while the second stage should satisfy the nitrogenous biochemical oxygen demand (NBOD). A minimum hydraulic detention time of four hours in the first stage and five hours in the second stage will be necessary. Clarifiers following the first stage should provide a maximum overflow rate of 800 gpd/ft^2 at 20.0 MGD, while clarifiers following the second stage should provide a maximum overflow rate of 600 gpd/ft^2. The aeration basins as well as the clarifiers should be designed for parallel construction with a minimum of three basins or tanks for each process. This type of design will allow for increased flexibility and performance during operation. Each tank should be sized for only the portion of total flow that it will treat.

Assuming an oxygen requirement of 1.5 pounds per pound of BOD_5 removed and 4.6 pounds per pound of NH_3-N removed, the blower capacity required is approximately 45,000 cfm. This blower capacity can be provided with a different aeration system. A sufficient number of blowers should be provided to enable the design oxygen transfer to be maintained with the layout capacity unit out of service.

Multimedia filters are necessary for attaining the stringent effluent limitations and will be designed for a hydraulic loading of 3 gpm/ft^2. The existing movable tertiary filters at the South Buffalo Creek plant should be salvaged and installed with this new facility. However, these existing filters are designed for only 6 MGD and additional facilities for the remaining 14 MGD must be constructed.

Disinfection will be provided with chloriantion facilities including a contact basin and a chlorine feed system. To provide the required contact time of 30 minutes, a minimum chamber volume of 55,700 cubic feet is necessary.

Approximately 20 tons/day of primary and waste-activated sludge will be removed for processing and ultimate disposal. Assuming a solids loading rate of 10 pounds/square foot/day, approximately 4,000 square feet of flotation-thickened surface area will be required. The thickened sludge can be dewatered with vacuum filters before incineration. These vacuum filters will require a minimum surface area of 1,400 square feet assuming a filter yield of 3.5 pounds/square foot/hour and 56 hours of operation per week. A two to three ton/day capacity incineration should be sufficient for this new facility and will probably require fuel oil for operation. Scrubbers or other air pollution control equipment must be installed and will be required to comply with new source performance standards.

Electrical costs to operate the new facility will approximate $400,000 per year at 20.0 MGD. This cost represents an equivalent electrical annual consumption of approximately 11,500 megawatt-hours, about 0.5 percent of the total electrical consumption in Greensboro.

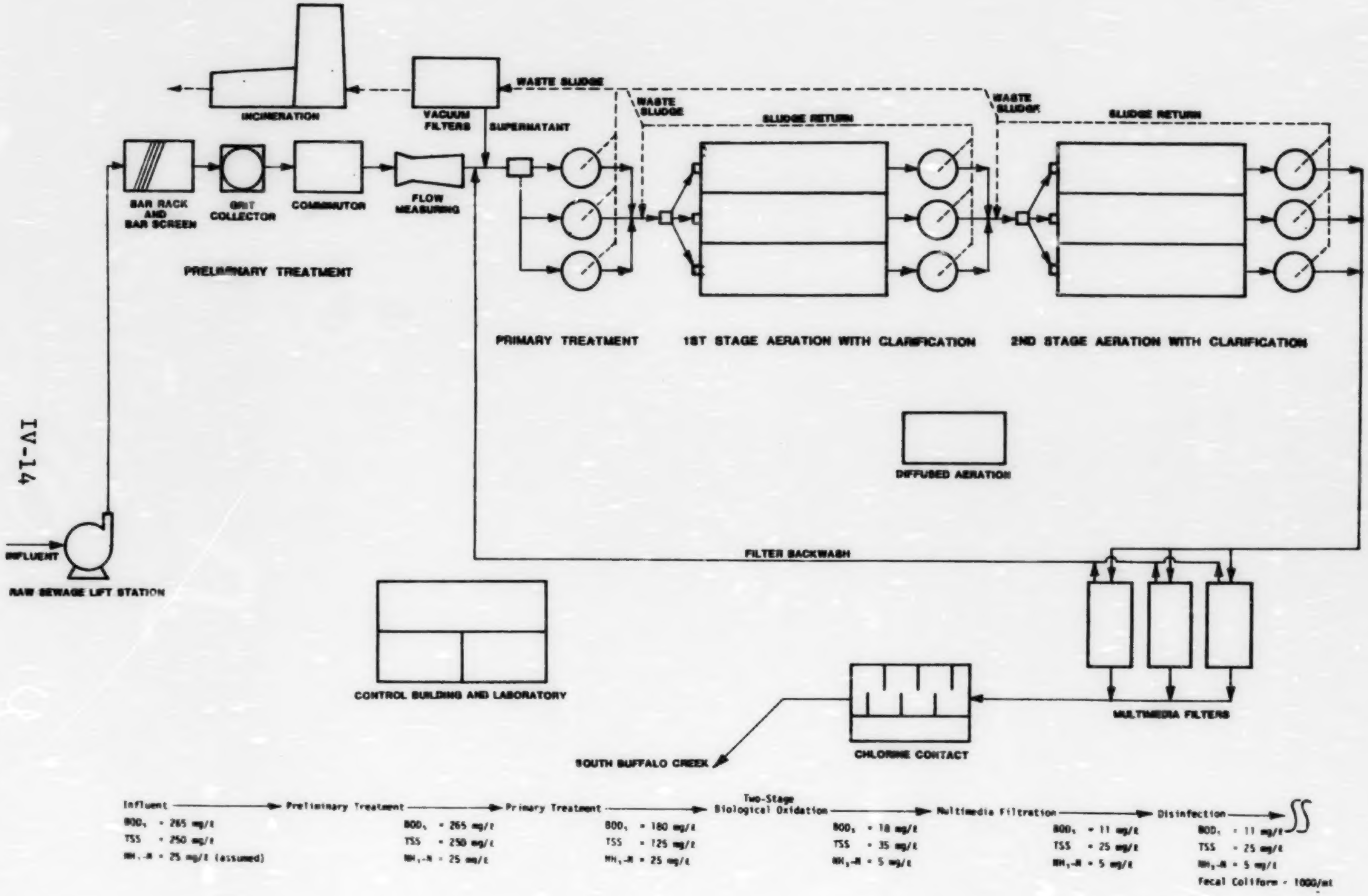
The only chemical which will be used at the site is chlorine for disinfection. At the design flow of 20.0 MGD, approximately 250 tons of chlorine will be required annually at a cost of approximately $45,000.

Construction of the new facility will require approximately 40 acres of land out of approximately 400 acres which are available to the city. This proposed site will offer little constraint to future expansion and improvements. Construction of this facility should be complete within 24 to 30 months after construction begins but may vary depending on available materials and time required for deliveries.

A schematic of the proposed new facility and projected pollutant removal or mass balance for each level of treatment is shown in Figure IV-4. Figure IV-5 shows a possible layout of the actual proposed facilities; however, other possibilities exist and this proposed layout should in no way constrain the design engineers. Figure IV-6 is an artist's conception of the proposed new facility.

A true or useful hydraulic profile through this facility can not be completed until the detailed drawings and specifications included in the 201 Step II activities are completed. The selection, arrangement, and placement of necessary facilities will depend on a detailed site survey including topographical features and engineering geologic characteristics. However, it is estimated that incoming wastewater will be lifted approximately 55 feet from the outfall elevation of approximately 675 feet to the preliminary treatment facilities located at an elevation of 730 feet. The profile through the plant will be dependent on the arrangement and particular design of the unit processes. The treated wastewater will be discharged back to the South Buffalo Creek at a stream surface elevation of approximately 690 feet.

The existing South Buffalo Creek facility currently employs 17 personnel for operation and maintenance. This new facility should be staffed with approximately twenty-five personnel on weekdays, eight on weeknights, and twelve on weekends for a total employment of forty-five. The complete staff should include three



INCINERATION
VACUUM FILTERS
WASTE SLUDGE
SUPERNATANT
WASTE SLUDGE
SLUDGE RETURN
WASTE SLUDGE
SLUDGE RETURN
BAR RACK AND BAR SCREEN
GRIT COLLECTOR
COMMINUTOR
FLOW MEASURING
PRELIMINARY TREATMENT
PRIMARY TREATMENT
1ST STAGE AERATION WITH CLARIFICATION
2ND STAGE AERATION WITH CLARIFICATION
DIFFUSED AERATION
INFLUENT
RAW SEWAGE LIFT STATION
FILTER BACKWASH
CONTROL BUILDING AND LABORATORY
MULTIMEDIA FILTERS
CHLORINE CONTACT
SOUTH BUFFALO CREEK
Influent
BOD₅ = 265 mg/ℓ
TSS = 250 mg/ℓ
NH₃-N = 25 mg/ℓ (assumed)
Preliminary Treatment
BOD₅ = 265 mg/ℓ
TSS = 250 mg/ℓ
NH₃-N = 25 mg/ℓ
Primary Treatment
BOD₅ = 180 mg/ℓ
TSS = 125 mg/ℓ
NH₃-N = 25 mg/ℓ
Two-Stage Biological Oxidation
BOD₅ = 18 mg/ℓ
TSS = 35 mg/ℓ
NH₃-N = 5 mg/ℓ
Multimedia Filtration
BOD₅ = 11 mg/ℓ
TSS = 25 mg/ℓ
NH₃-N = 5 mg/ℓ
Disinfection
BOD₅ = 11 mg/ℓ
TSS = 25 mg/ℓ
NH₃-N = 5 mg/ℓ
Fecal Coliform = 1000/ml

FIGURE IV-4 SCHEMATIC OF PROPOSED NEW SOUTH BUFFALO CREEK FACILITY

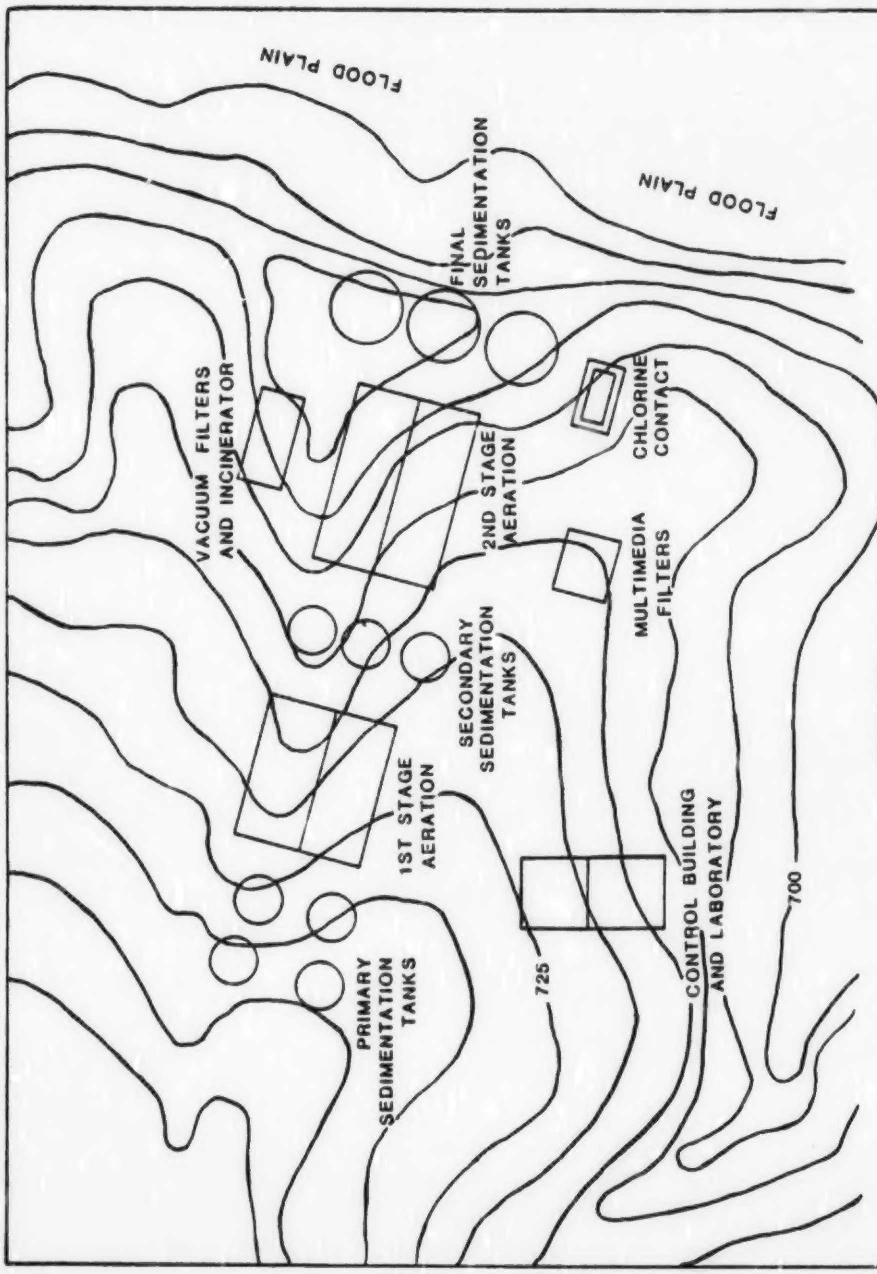

FLOOD PLAIN
FLOOD PLAIN
FINAL SEDIMENTATION TANKS
VACUUM FILTERS AND INCINERATOR
CHLORINE CONTACT
2ND STAGE AERATION
MULTIMEDIA FILTERS
SECONDARY SEDIMENTATION TANKS
1ST STAGE AERATION
CONTROL BUILDING AND LABORATORY
700
725
PRIMARY SEDIMENTATION TANKS

FIGURE IV-5
PROPOSED NEW SOUTH BUFFALO CREEK PLANT

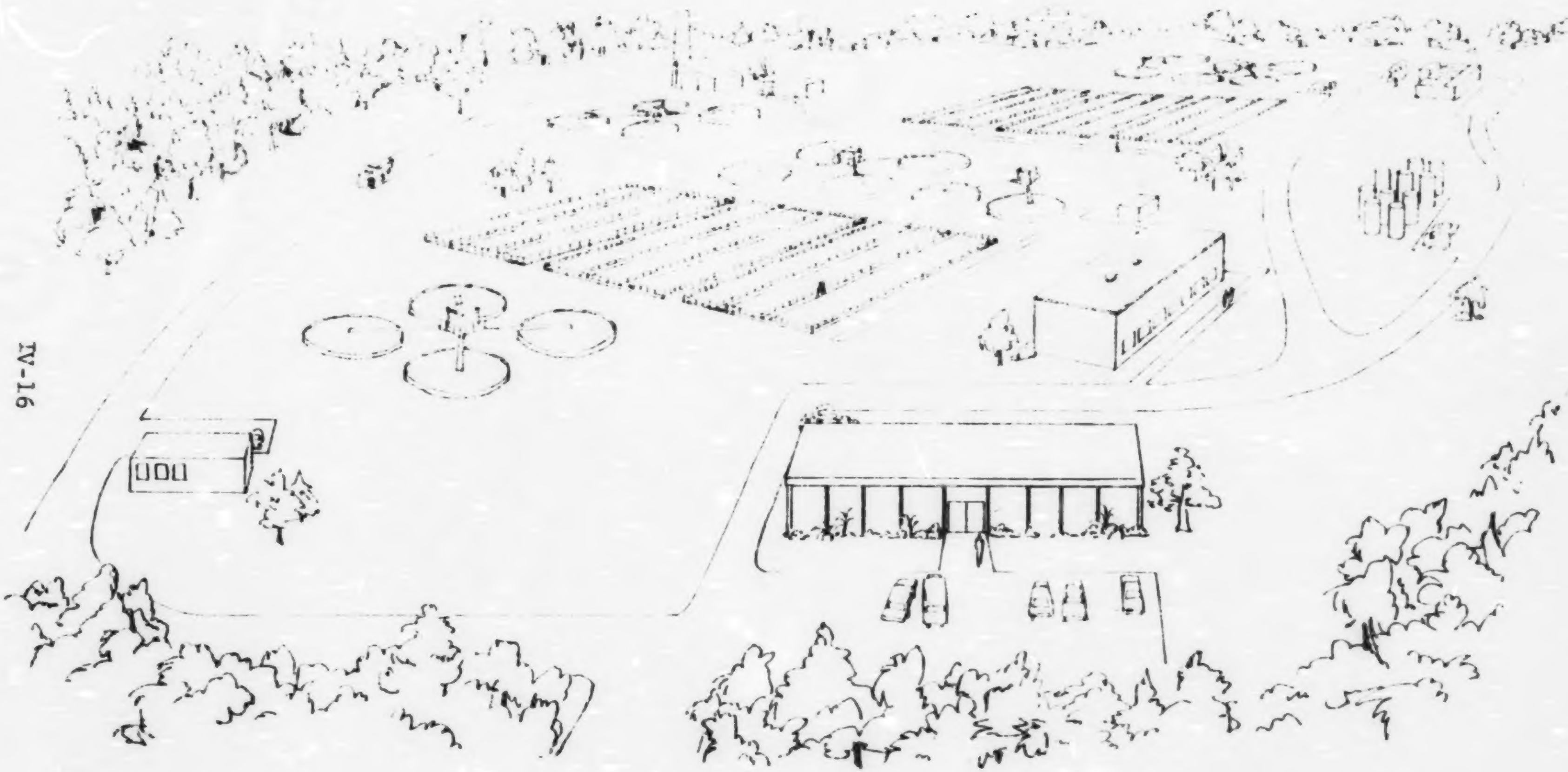


FIGURE IV-6

ARTIST'S CONCEPTION OF PROPOSED NEW SOUTH BUFFALO PLANT for supervisory, one for clerical, twenty-five for operations, ten for maintenance, three for laboratory, and three for yardwork.

3. Collection and Sewer System

No specific collection/interceptor system expansion is included with this proposed action. However, as the city continues to grow, additional sewer service and collection system will necessarily be provided.

To transfer the raw wastewater from the existing South Buffalo plant to the new facility, a new 26,000-foot, 60-inch outfall sewer will be constructed along South Buffalo Creek. This outfall will be located away from the stream as much as possible to minimize adverse impacts. The location of this outfall is shown with the proposed action in Figure IV-1.

V. ENVIRONMENTAL EFFECTS OF THE PROPOSED ACTION

A. General

The proposed action has been analyzed to determine the primary and secondary impacts and the short-term or long-term nature of these impacts. Some impacts described in this chapter, including primary water quality impacts and numerous secondary impacts related to the growth of the Greensboro urban area, address conditions that will prevail only at the end of the 20-year design period. Initial operational impacts will be considerably less than these ultimate conditions, but they will gradually increase to the level of effect described herein. The impact analysis focuses on the wastewater treatment plants and system described in Chapter IV.

To facilitate reference and integration with results presented in Chapter II, Existing Environment, the discussion of impacts follows the outline used in Chapter II. Impacts are discussed for each environmental parameter or category, and both beneficial and adverse effects are considered. Value judgements have been avoided to maintain objectivity, but some impacts have been assessed primarily on the basis of professional judgement in the absence of definitive information. On the other hand, some impacts have been evaluated using quantitative or semi-quantitative methods, and some have been assessed by using a data base that is too detailed to incorporate into the Draft EIS. These supplementary descriptions, data, concept formulations, and rationale are included in the Technical Reference Document (RA-R-406) generated by the evaluation process. Higher order impacts that must be considered pursuant to CEQ guidelines, such as irreversible and irretrievable resource commitments and the relationship of the project to long-term productivity, are integrated into the discussions in this chapter.

B. Natural Environment

The natural environment is comprised of those areas of the total environment that are external to man and his social organization. For consistency with Chapter II, impacts of the proposed action upon the natural environment are presented in two major components, physical and biological.

1. Physical Components

Impacts accruing from implementation of the proposed action upon physical components of the environment, i.e., atmosphere, land, water, and land/water interface, are described in the subsections that follow.

a. Air Quality

The standard "criteria" pollutants describing air quality impacts are total suspended particulates (TSP), sulfur dioxide, nitrogen dioxide, carbon monoxide, and hydrocarbons (photochemical oxidants). Not a part of the federal air quality standards but of concern to this project is the airborne pollutant, odor. The impact of this pollutant is addressed in the next section.

Of the five criteria air pollutants, only TSP (i.e., dust) is of any significance to the project. Small amounts of the other pollutants will be emitted during construction and operation, but their impact on existing air quality will be negligible. Fugitive dust emissions resulting from construction activities, particularly for the South Buffalo interceptor and the new treatment plant, will cause short-term local increase in TSP levels. Studies have shown that the quantity of dust generated can be correlated with climate, soil type, and extent of construction activity (EN-071).

From these studies, the amount of dust that will become airborne and suspended were estimated. For the level of construction activity required for upgrading North Buffalo plant, building the new South Buffalo plant, and abandoning the existing South Buffalo plant, the following amounts of TSP are expected to occur per month of activity:

North Buffalo	- negligible
Existing South Buffalo	- 20 tons
New 20 MGD plant	- 40 tons

These estimates are based on maximum expected emission rates of 1 ton of TSP per acre of construction activity. They represent extreme maximum amounts that may occur; actual TSP levels may be significantly less, depending on the factors listed above. They do, however, provide clues that TSP generation could have an adverse impact on air quality and, therefore, warrant consideration for mitigative measures as described in Chapter VI.

Impacts on air quality of system operation employs primarily electrically operated equipment and will, therefore, not create a source of additional air pollutants. The proposed incinerators for the new plant will be equipped with wet scrubbers to limit air pollutant emissions. The North Buffalo plant is currently operated with similar pollution control equipment (GR-283). With properly functioning air pollution control equipment, no appreciable degradation in air quality is expected from the plant operations.

Secondary air quality impacts will occur due to growth-related aspects of the proposed action. The population increases that will accompany sewage capacity expansion will most likely cause increases in air pollutant emissions in the study area. Since Guilford County is an Air Quality Maintenance Area for TSP, governmental agencies are charged with the task of not allowing such emission increases to violate any of the national or state air quality standards. For the other pollutants, Guilford County is within the standards. Increases in these other pollutants due to growth are controlled by non-significant deterioration regulations. It is not anticipated that the proposed action will have any significant deleterious secondary air quality impacts.

b. Odor

This section addresses community impact of potential odors emitted from components of the proposed action. Analysis of impacts will center on odors emitted from the treatment plants. No adverse impact is anticipated from any of the interceptors and force mains. Pumping stations will rarely have odors associated with their operations. Generally, the odor impacts of the proposed action can be summarized as follows: (1) replacement of the South Buffalo plant with a new plant at the site downstream should have a significant benefit to the large population surrounding the existing plant; (2) installation of the new South Buffalo plant should have minor impact because of the low population density within one mile of the proposed site and the large buffer zone provided by the site; (3) the upgrading of the North Buffalo plant to meet effluent limits in and of itself will not substantially improve the odor situation at that plant. These aspects will be discussed on a unit process basis below. Mitigating measures for certain processes may be desirable as discussed in Chapters IV and VI.

The determination of odor impact from the new South Buffalo plant is based on a study performed to evaluate a proposed plant site in Jacksonville, Florida (EN-483). Based on a comparison of public opinion regarding treatment plants in Ft. Lauderdale, Florida, and Canton, Ohio, a generalized odor impact model was developed (see Figure V-1).

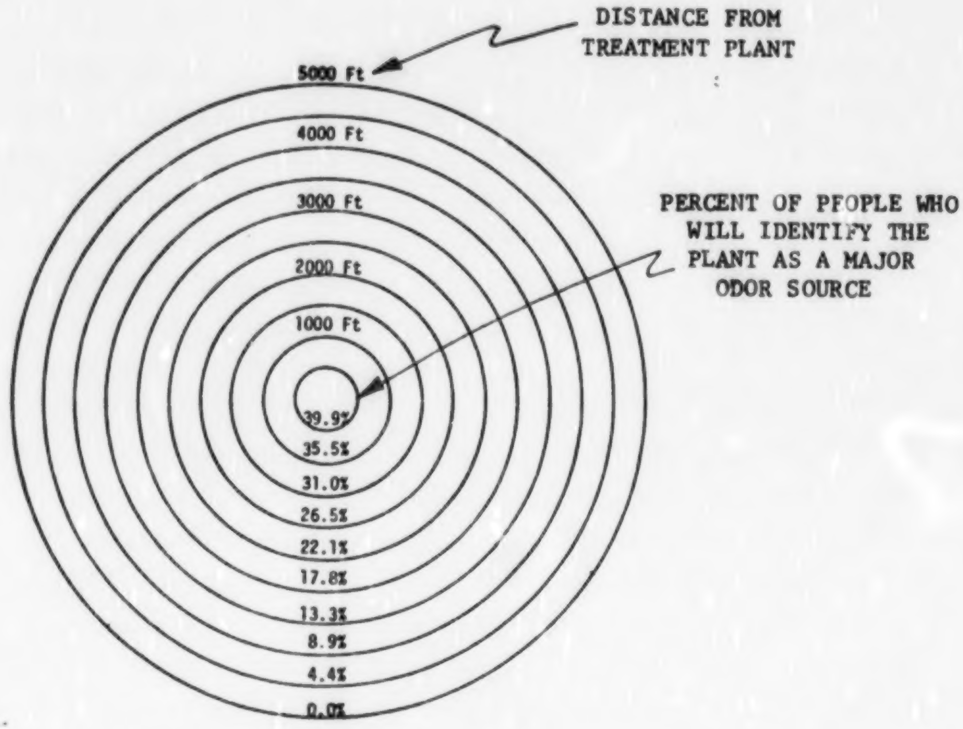

DISTANCE FROM TREATMENT PLANT
5000 Ft
4000 Ft
3000 Ft
2000 Ft
1000 Ft
PERCENT OF PEOPLE WHO WILL IDENTIFY THE PLANT AS A MAJOR ODOR SOURCE
39.9%
35.5%
31.0%
26.5%
22.1%
17.8%
13.3%
8.9%
4.4%
0.0%

FIGURE V-1

GENERALIZED ODOR IMPACT MODEL

PERCENT OF PEOPLE WHO WILL IDENTIFY PLANT
AS A MAJOR ODOR SOURCE

The referenced study shows that beyond one mile from a plant, no significant impact should occur. In addition, the study concluded that no wind-direction correlation could be determined. That is, radial distance away from the plant is a more accurate indicator of relative impact rather than direction from the plant. This can be explained by the meteorological phenomena associated with high odor levels. Periods of stagnation, i.e., light, variable winds, generally occur in the summer. Hot summer temperatures are also most conducive to odor generation at the treatment plant. The light, variable winds transport the odors radially in all directions from the plant. Thus, no one direction will be affected more than another. The odors will also be dispersing horizontally and vertically, thus reducing in concentration. At some distance away from the plant, the odor becomes imperceptible. These basic conclusions should be similar for the new South Buffalo plant site. The low population density within one mile of the proposed site indicates that odor impacts should be small. Obviously if population densities surrounding the proposed site increase during the planning period, a greater impact could be expected. An indication of the percentage of people affected can be determined by use of Figure V-1.

Another approach to odor impact analysis is to investigate the individual sources of odor at the treatment plant. At the new South Buffalo plant odors may be produced during the pretreatment stage from the grit chamber. In addition, the primary clarifiers may be an odor source of compounds such as hydrogen sulfide, ammonia, etc. The sludge handling processes also may produce objectionable odors. The vacuum filters are the most probable source in the sludge operations. On the other hand, the incineration step can be termed a positive odor impact because most combustible malodorous compounds are destroyed.

It should be emphasized that the production of odors at the plant will vary seasonally and daily according to plant operating characteristics and prevailing weather conditions. Obviously a well-designed and maintained plant is less likely to produce objectionable odors.

The situation at the North Buffalo plant can be viewed in a similar manner. The proposed action involves the upgrading of the facilities at this plant. This action, per se, will not substantially reduce odors at the plant. Consequently, reviewing Figure V-1, about 36%, 27%, and 18% (and so on) of people living at distances of 1,000, 2,000, and 3,000 feet of the site will be affected by the plant odor emissions. This represents approximately 15, 193, and 213 people, respectively. The shopping center to the northwest will continue to experience occasional odor episodes. The merits of installing additional odor controls at this plant and at the new South Buffalo plant are discussed in Chapter VI.

c. Noise

(1) Methodology and Criteria

The methodology and criteria for predicting human and animal responses to noise pollution generated by construction and operation of the proposed wastewater treatment facilities are presented in the paragraphs that follow.

Studies conducted and sponsored by EPA and others resulted in the development of measures for determining levels of noise and duration of exposure that causes varying levels of human response (EN-108). The objective of these studies was to treat noise as a pollutant and ascertain potential adverse health and welfare effects. Using the World Health Organization definition of health and welfare "...a total physical, physiological, and psychological well-being of the individual" an array of noise "doses" was established for estimating human responses.

A single measure, L_{dn}, the long-term equivalent sound level was devised. It uses, as the basis for calculation, a term that approximates the hearing response of the human ear. This term is called the A-weighted sound level. L_{dn} also accounts for varying responses of humans to noise for both day and nighttime periods. It applies a 10 decibel (dB) penalty against noise generated during periods from 11:00 p.m. to 7:00 a.m.

The criteria, in general, defines those noise levels that are considered essential for safeguarding human health in a variety of human activities. For the purpose of this assessment it may be assumed that when L_{dn} exceeds 55 dB, noise pollution will have an adverse impact. This level applies to "outdoor and residential areas, farms and other outdoor areas where people spend widely varying amounts of time, and in other places in which quiet is the basis for use" (EN-108).

Additional measures are available for more detailed analysis. The ability to communicate effective depends upon the presence of noise that acts as a "masking" agent. Such noise interferes with both face-to-face and telephone communications. The values presented in Tables V-1 and V-2 provide a tabulation of limiting sound level (as measured on the A-weighted scale of a sound level meter) that will permit effective communication.

TABLE V-1

MAXIMUM A-WEIGHTED SOUND LEVELS THAT WILL PERMIT UNDERSTANDABLE SPOKEN COMMUNICATION FOR VOICE LEVELS AND LISTENER DISTANCES SHOWN

Distance (feet)	Ambient Sound Level in dBA			
	Vocal Effort			
	Low	Normal	Raised	Very Loud
1	60	66	72	78
2	54	60	66	72
3	50	56	62	68
4	48	54	60	66
5	46	52	58	64
6	44	50	56	62
12	38	44	50	56

TABLE V-2

QUALITY OF TELEPHONE USAGE IN THE PRESENCE OF STEADY-STATE MASKING NOISES

Noise Level (dBA)	Telephone Usage Quality
30-50	Satisfactory
50-65	Slightly Difficult
65-75	Difficult
Above 75	Unsatisfactory

The above basis for noise evaluation covers most situations in the Greensboro area. However, in some very quiet suburban and rural zones, it was necessary to assess impact on the basis of "change" in sound level. This change is important in assessing the acceptability of an added noise source. A 2-3 dB increase is hardly noticeable, while a 5 dB change is readily apparent. Most humans perceive a 10 dB change as doubling of the loudness of sound and each additional 10 dB increase is judged as doubling the loudness.

The effects of noise upon wildlife and domestic animals are not well understood. Studies of animals subjected to varying noise exposures in laboratories have demonstrated physiological and behavioral changes, and it may be assumed that these reactions are applicable to wildlife. However, no scientific evidence currently correlates the two. It is known that large animals adapt quite readily to high sound levels. Conversely, it has been demonstrated that loud noise disrupts brooding in poultry and consequently can affect egg production.

The major effect of noise on wildlife is related to the use of auditory signals. Acoustic signals are important for survival in some wildlife species. Probably the most important effect is related to the prey-predator situation. An animal that relies on its ears to locate prey and an animal that relies on its ears to detect predators are both impaired by intruding noise. In addition, the reception of auditory mating signals could be limited, and reproduction could be affected. Distress or warning signals from mother animals to infants (or vice versa) or within groups of social animals could be masked and such masking could lead to increased mortality. There are clues that short-term high noise levels may startle wild game birds and stop the brooding cycle for an entire season (ME-050).

In this study, noise levels were predicted using a simple model that incorporates measured data from major sound sources and standard acoustical field equations. Results will be presented in terms of L_{dn} as a function of distance from noise sources. Figure V-2 illustrates the basis for general assessment of expected community response to various levels of noise.

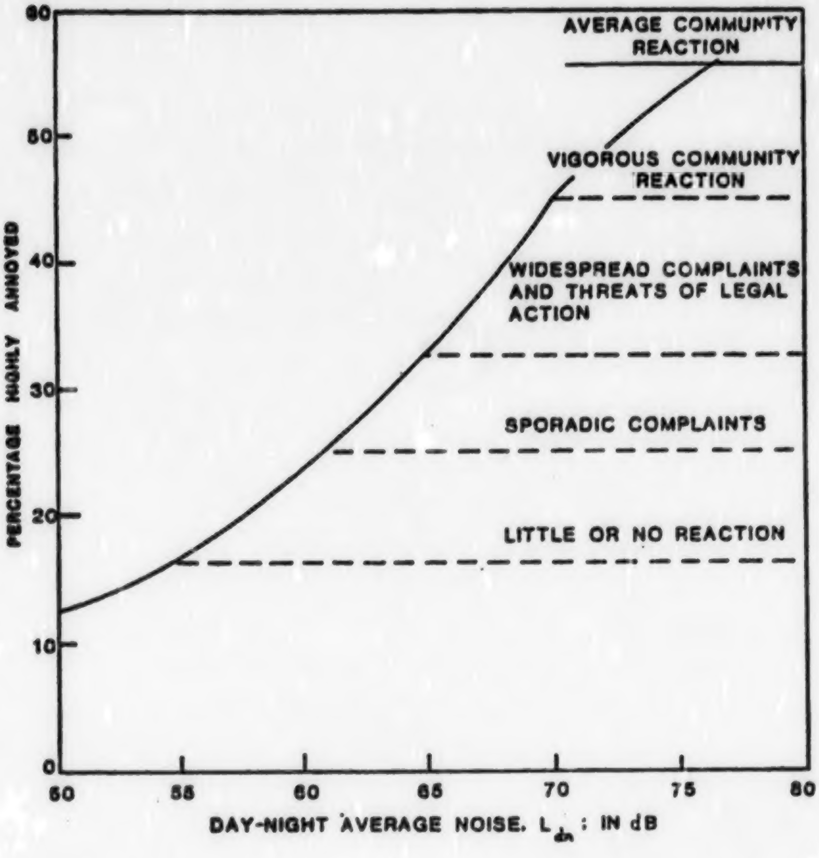


FIGURE V-2

EXPECTED COMMUNITY RESPONSE TO VARIOUS LEVELS OF NOISE

(2) Noise Impacts

General

Noise associated with the construction and operation of the wastewater treatment system can be described as either short-term or long-term. Short-term noise is that which will occur during the construction phases for sewer interceptors and sewage treatment plants (STP's); long-term noise results from operation of the STP's.

Short-term noise is caused by activity of construction equipment along and near interceptors and at each STP location. To determine the possible adverse effects from construction, an array of various construction equipment types was assumed. Based on the radiated sound pressure level of each equipment item, predictions were performed using standard acoustical field equations and assuming worst-case mitigating factors such as a standard day, no attenuating barriers (such as trees) and acoustically-untreated noise sources. This approach yields results that may be considered as a worst-case noise condition and will provide clues about the adverse impact that may be caused.

Construction of an interceptor requires equipment that is standard in earth-working and pipeline machinery inventories. A right-of-way (ROW) is cleared with dozers and debris is removed with front-loaders and dump trucks. Crews with chain-saws are active for short periods in timbered areas. A ditch-digger with backhoes follows; rock drills and blasting may be required in hard-rock areas. The pipe laying activity requires heavy trucks, a crane, dozers, and other equipment. Essentially these same types of equipment will be required for construction of the STP. Typical sound level spectra for the above equipment items are given in Table V-3 (BO-054).

TABLE V-3

SOUND PRESSURE LEVEL IN dB AT A DISTAHCE OF 50 FEET FROM VARIOUS TYPES OF CONSTRUCTION EQUIPMENT

	Frequency (Hz)								
	63	125	250	500	1000	2000	4000	8000	dBA
Dozer (Soil 270 hp)	75	73	80	77	75	72	65	61	77
Dump Truck	73	78	80	75	67	65	58	50	72
Back-Hoe/Front Loader	73	73	73	73	73	68	62	58	72
Rock Drill	86	94	91	90	93	93	91	89	98
Crane	83	91	88	87	83	77	71	65	86
Concrete Mixer	70	70	70	70	70	63	57	51	72

Assuming that the construction activity occurs from 8:00 a.m. to 5:00 p.m. and that ambient sound levels are 50 dBA from 5:00 p.m. to 11:00 p.m. and 45 dBA until 8:00 a.m., the values of L_{dn} in Table V-4 were computed as a function of distance for each type of equipment

TABLE V-4

L_{dn} IN dB AS A FUNCTION OF DISTANCE FROM VARIOUS TYPES OF CONSTRUCTION EQUIPMENT

	Distance from Source (Feet)				
	250	500	750	1000	2000
Dozer	60	56	54	--	--
Dump Truck	56	--	--	--	--
Back Hoe	59	55	--	--	--
Rock Drill	81	75	73	70	62
Crane	70	63	60	58	--
Concrete Mixer	57	--	--	--	--

Referring to the criteria of Figure V-2 and L_{dn} = 55 dB as the threshold value for creating annoyance, it is seen that operation of certain equipment items will be a source of concern at certain distances. These are summarized in Table V-5.

TABLE V-5

DISTANCES FROM CONSTRUCTION EQUIPMENT AT WHICH ANNOYANCE OCCURS DUE TO SOUND LEVEL

Equipment Item	Distance (ft)
Dozer	100
Dump Truck	100
Back Hoe	500
Rock Drill	>2,000
Crane	2,000
Concrete Mixer	500

The actual sound levels depend upon equipment duty cycle and the number and mixture of types that are operating simultaneously. In general, however, mild adverse reaction may be expected during development of the ditch at a distance of up to about 700 feet due to noise caused by dozers, backhoes, and trucks. Laying the sewer pipe will cause a more severe impact, since noise from crane operations will dominate the noise field up to 2,000 feet. Where blasting is required, the rock drill operation will be a major noise source causing extreme annoyance up to distances of about 2,000 feet.

Without the presence of human receptors of noise, environmental impact of noise upon human activity will not exist. Construction of portions of sewer mains will take place on the fringes of populated areas. Many more people will be exposed to this construction noise than construction and operation noise at STP's. Construction noise can be better tolerated by human inhabitants than long-term noise because of its transient nature. This observation does not preclude the possibility of generating considerable adverse reaction, particularly with the higher noise offenders.

The length of time that such noise intrusion will occur is highly variable, depending upon soil conditions, accessibility, weather, and other factors. Assuming that approximately 3,000 feet of interceptor can be completed in a typical one-month period, the length of time a given group of residents will be affected can be estimated directly. As discussed previously, noise intrusion can be expected to cause adverse human reaction at distances typically up to about 1,000 feet from the center of construction activity. At a completion rate of 3,000 feet per month, such inhabitants could expect noise to be in excess of limiting threshold levels for a total time of two weeks to one month.

Construction of the South Buffalo treatment plant will require up to about 2½ years. Since there are no residents within 2,000 feet of the site, actual on-site construction is not expected to create an area of environmental concern. Additional noise generated by construction vehicle traffic entering and leaving the site area will increase levels along Huffine Mill Road, but this activity will occur during normal working hours and is not expected to be a source of annoyance. Noise from blasting operations at the site will generate infrequent short pulses of noise. These operations will not be of sufficient intensity to radiate airborne noise to be heard in inhabited areas, although a seismic pressure wave may be detectable along Huffine Mill Road. The acoustical seismic energy of these pulses should be sufficiently abated in a distance of 2,000 feet to be hardly noticeable.

Construction associated with upgrading North Buffalo plant will require basically the same types of equipment required in the construction of a new plant. For this location, approximately 42 people live within 1,000 feet and 716 people within 2,000 feet of the construction activity. As shown in Table V-4, except for rock drilling operations, only the crane radiates noise levels that will exceed the 55 dB threshold criterion. Little or no blasting is required and consequently, a rock drill will probably not be needed at the site.

Occasional encroachment of site-generated noise may be noticeable during the upgrading period within 1,000 feet of the construction activity, but the level of activity is not nearly as intense or continuous as development of a "grass-roots" plant such as the one on South Buffalo Creek. Based upon the previously discussed criteria and noise level predictions, no appreciable adverse noise impacts are expected from the upgrading of the North Buffalo plant.

The impact of noise from construction upon wildlife is not considered serious. Inhabitants of a particular area will likely vacate it during construction more due to the activity than because of the increased noise. Birds and other animals are expected to return to the affected habitat after the activity ceases. Noise within 1,000 feet of STP's could affect birds and those other animals that rely upon auditory signals to find mates, stake out territories, recognize young, detect and locate prey, and evade predators. However, experience indicates that the type of animals in the area adapt quite readily to noise of the levels indicated. Therefore, the effect of construction noise on wildlife is not considered to be an appreciable problem.

Noise caused by operation of the treatment plants will be dominated by equipment associated with the diffusion aeration system. This includes the large electric motors, control valves, high pressure piping, and discharge of air into aeration basins. Some water movement, splashing and bubbling, will be present but will not be of sufficient intensity to be noticeable over a few hundred feet from the source.

In an acoustically untreated condition (no noise control features) the aeration system will generate sound pressure levels at a distance of 50 feet with the approximate spectrum shown in Table V-6.

TABLE V-6

SPECTRUM OF SOUND PRESSURE LEVELS FROM DIFFUSED AERATION SYSTEM

Frequency (Hz)	Sound Pressure Levels at 50 ft (dB)	Frequency (Hz)	Sound Pressure Levels at 50 ft (dB)
63	64	2000	84
125	59	4000	76
250	63	8000	69
500	67	dBA	86
1000	74		

Assuming that these sound pressure levels are constant for both daytime and nighttime periods, L_{dn} was computed as a function of distance from the center of each plant as shown in Table V-7.

TABLE V-7

L_{dn} AS A FUNCTION OF DISTANCE FROM SEWAGE TREATMENT PLANTS

Distance (ft)	L_{dn} (dB)
250	75
500	70
750	64
1000	62
2000	53

Again, no adverse reaction is expected from noise associated with operation of the South Buffalo plant because there are no inhabitants within 2,000 feet and radiated sound level is well below 55 dB at distances greater than 2,000 feet. For the North Buffalo plant, some people may suffer a slight degree of annoyance and initiate complaints about the noise (see Figure V-2). It is expected that those living to the north of the plant may be subjected to interference of outdoor activity especially during the late evening hours. People living to the south and east of the plant will probably not notice the operational noise primarily because of the natural buffer of vegetation and topography.

d. Geology

The bedrock geology of the area around the proposed new treatment plant site has been mapped as biotite granodiorite (RA-R-406). However, several local outcrops at the site indicate the site is underlain in part by a dark-colored, more basic igneous or metaigneous rock than granodiorite. A coring program for a potential quarry at the site showed that this rock, which is very hard, resistant, and tough, occurs in erratic patches in the area (BU-264). Where it occurs, the soil is thin, and blasting will likely be required for excavation for the treatment plant site. Elsewhere, the more typical granodiorite is overlain by an 8 to 20 foot thick mantle of soil and weathered rock (BU-264) which will not require blasting. Blasting will be the major adverse impact associated with the geology of the site. No other adverse geologic impacts are anticipated.

The topography of the proposed new plant site is flat to gently rolling in the uplands portion and slightly more rugged near South Buffalo Creek and its tributaries. The slopes are flat to very gentle in the uplands and gentle to moderate near the streams. No adverse environmental impact resulting from steep slopes is anticipated. No alteration of the drainage patterns in the area is expected from the relatively small construction site. However, the two small ponds that are impounded on the site may be intentionally destroyed during construction or they may be inadvertently silted in by sediment from the construction site. These impacts are discussed in more detail in the aquatic biology impacts section.

No adverse impact on geology or topography is expected from the expansion of the North Buffalo treatment plant. This expansion will be confined to the boundaries of the existing plant site, so no significant increase in adverse impact is anticipated

The pipeline that will transport the raw sewage to the new site from the existing South Buffalo treatment plant will likely require blasting in some segments. Bedrock outcrops were observed at two locations in the floodplain near the creek which indicates that the creekbed is close to bedrock at least in some sections of the creek. Blasting will be necessary in these sections, but the length of stream where blasting will be required is not expected to exceed 10% of the total stream length. Very little adverse impact on the geology and geomorphology of the stream is anticipated because the natural state of the stream has already been extensively disturbed by a previous channelization project that extends downstream almost to the proposed site. Some disturbance may occur in the length of stream (1000 to 1500 feet) that has not been channelized, but these impacts are expected to be minimal.

The most important secondary geologic impacts of the proposed project are related to the urban growth that will occur in the Greensboro area. However, the geologic substrate in the area is generally well-suited to urbanization, so these impacts should be minimal. Blasting of hard bedrock will be required in some areas, but will be highly localized (affecting areas of less than a few hundred acres) and of short duration (generally less than a month for large projects). Steep slopes (greater than 25%) are rare (less than 1% of the area) and should not present problems for urban growth.

e. Soils

The soil at the new treatment plant location has been mapped as fine sandy loam (US-562). This soil is a typical well-drained soil of the Piedmont uplands. The soil thickness ranges from 20 to 38 inches, and the depth to hard rock is generally from 4 feet to more than 10 feet. At the site, however, the soil is apparently thinner than normal in some places because of more resistant bedrock parent material (see Geology section). The soil depth in these areas probably averages less than three feet. Bedrock crops out in places at the site, and the soil thickness is zero in those areas. The subsoil (B horizon) in most of the site area has low permeability and high shrink-swell potential. The soil eroidibility K factor (an empirical measure of the erodibility of soil ranging from 0.02, meaning nonerodible, to 0.69, very high erosion potential; most soils fall between 0.2 and 0.5) is about 0.40 which indicates a moderately high susceptibility to erosion.

The chief impacts related to soils will likely be associated with the new sewage treatment plant. As noted in the geology section, the thin soils and shallow depth to bedrock in some parts of the site will mean that blasting will probably be required. The high shrink-swell subsoil could cause structural stress problems for plant facilities that are not emplaced in bedrock. The moderately high K factor indicates that erosion is a potential problem when the site is devegetated during construction operations. The sediment derived from this erosion is not expected to contribute to water quality problems (increased turbidity) of South Buffalo Creek. The quantity of sediment generated will be small, and runoff from the site will flow over a vegetative buffer consisting of about 500 feet of relatively flat, grassy land. Most of the sediment will be removed from suspension before the runoff reaches the creek and will be added to the soil downslope of the site. The treatment plant itself will remove approximately 40 acres of potentially moderately productive soil from future crop productiveness. The present use of this soil is limited to slightly improved pastureland, however. Inasmuch as sludge will be disposed of by centrifugation and incineration instead of by the use of sludge drying beds, the suitability of the soils for drying beds is not important. Should drying beds have to be used in the future, the impermeable subsoil should make the soils suitable for this, provided excavation for the beds does not extend below the subsoils.

No adverse soils impacts are expected as a result of the upgrading of the North Buffalo treatment plant because the upgrading will be limited to the existing plant boundaries. A small amount of additional sediment may be derived from erosion of the soils at the construction site, but this impact is expected to be minimal.

The most important secondary impact of the proposed project on the soils will be the removal of 15 to 20 square miles of soil from potential productivity.[1] However, much of the soil in the urban periphery where most of the urbanization will occur is currently idle and nonproductive, so the actual loss of crop productivity will not be significant. Also, the urban growth would likely occur even without the proposed project. The character of the growth would be different in that the urban density would be less because septic tanks will be used. The total soil loss from productivity would be greater in this case (up to 45 square miles[2]) than it will be with the proposed project.

f. Water

Water-related impacts are addressed in the broad categories of surface water and ground water, and within these categories according to specific hydrologic aspects. In order to provide a "feel" for the total impact of the proposed action, primary and secondary effects within a hydrologic area of concern are considered together, where possible.

(1) Surface Water

While related, both streamflow and stream water quality will be directly affected in various specific ways as a result of the proposed action. In addition, secondary effects will also be imposed on reservoir quality. Impacts to these three aspects of the surface water regime in the Greensboro area are discussed under separate subsections in this part of the EIS.

---

[1] Assumes a reasonable mix of single-family and multiple-family residences projected for the year 2000 (see Table II-31).

[2] Assumes a density of one 3-member family dwelling per acre.

(a) Streamflow

The streams draining the study area are naturally small, relative to the proposed wastewater discharges (see Section II.A. 1.g.(2)). Consequently, perhaps the largest direct hydraulic impact of the proposed action will be the increased augmentation of the base flows of North and South Buffalo Creeks, especially in the upper reaches of the receiving streams below the outfalls. The significance of this effect is small because (1) both of these streams presently receive effluent in amounts similar to that proposed for discharge initially (10 MGD for North Buffalo and 9.6 MGD for South Buffalo), (2) the wastewater effluent will gradually increase to the design amount over a twenty-year period (16 MGD for North Buffalo and 20 MGD for South Buffalo), and (3) only minor channel erosion has resulted to date from increased flows, in that the low flow channel has naturally adjusted readily to the augmented flow downstream from the outfalls. The increase in low flows through these stream reaches during the design period therefore should not create large problems with respect to downstream channel erosion. Moreover, at more downstream points, say below the Reedy Fork-Buffalo Creek confluence, the increased assimilative capacity and increased instream value due to the larger low flows will be a substantial benefit. Inspection and hydraulic calculations of the effect of daily wastewater fluctuation indicate that the water-level elevations in the receiving creeks will not vary so appreciably for bank stability problems to be pronounced.

The removal of the wastewater discharge at the existing South Buffalo Creek plant to a point five miles downstream will, of course, decrease the flow in that reach substantially during dry-weather conditions. No significant hydraulic effects should accrue because this reach is almost entirely channelized. However, during extreme low flows, all but about 0.7 MGD in this five-mile reach will be industrial wastewater. This condition not only has significant implications for water quality, as discussed below, but this stream reach, which formerly contained poorly-treated municipal effluent, could be a breeding ground for vectors and other insects for the first few years of the existence of the new South Buffalo plant. Mitigative measures for this impact are discussed in Chapter VI.

Impacts to streamflow associated with necessary construction activities in or near the creek are minor, temporary, and of no identified consequence. Similarly the increased flooding potential as a direct result of the wastewater discharge to either stream is negligibly small; the design discharges for both the North and South Buffalo Creek plants are approximately one percent of the mean annual flood discharge (recurrence interval of 2.33 years) and much less in water-elevation increase for a flood that could cause significant flooding.

Although little stream water is presently utilized in the Greensboro area for irrigation, the additional flow in these creeks during dry weather conditions could be utilized for this purpose. However, without an extensive distribution network this additional water is of use to only those few farms located near the stream. In addition, the current 9.6 MGD flow from the present South Buffalo Creek plant will not be available for the 26,000 feet reach below the existing plant.

The most significant impact to streamflow rates in the Greensboro area are secondary effects related to the continued development of the area's watersheds. The major effects of this increased urbanization include higher flood peaks; more frequent flooding; and, if extensive, significant decreases in the natural low flows of area streams. These effects have already been noticed to some extent in the highly urbanized watersheds of North and South Buffalo Creeks where substantial increases in impervious cover (i.e., parking lots, streets, rooftops, etc.) have occurred.

The volume of runoff and ground water recharge which occurs during storm events is governed primarily by the infiltration characteristics of a watershed. As urbanization changes natural land use patterns which directly affect this infiltration rate, the percentages of rainfall going to runoff and infiltration change accordingly. The best example of this is the response of the watershed to changes in impervious cover. As less of the watershed's area becomes available for infiltration, a larger percentage of the rainfall ends up as runoff (Figure V-3). Decreases in the water available to recharge ground water aquifers is often the result, thereby lowering the ground water table. As most natural low flow of streams comes from ground water, this lowering of the ground water table often results in a decrease in the low flow of urban streams, thereby reducing the water available to assimilate the treated effluent and further degrading water quality.

The magnitude of the increased peak flows resulting from the impervious cover is also increased by smaller lag times associated with channelization and storm sewers. Because channelization and sewering both reduce the resistance to flow that occur in natural streams (i.e., vegetation, channel roughness, and channel meanders), the runoff occurs in a shorter time, thereby causing an increase in the peak flow rate (see Figure V-4).

An example of how basin lag time affects flood peaks with respect to various recurrence interval storms is shown in the following table for a small stream (drainage area = .55 square miles) in nearby Winston-Salem.

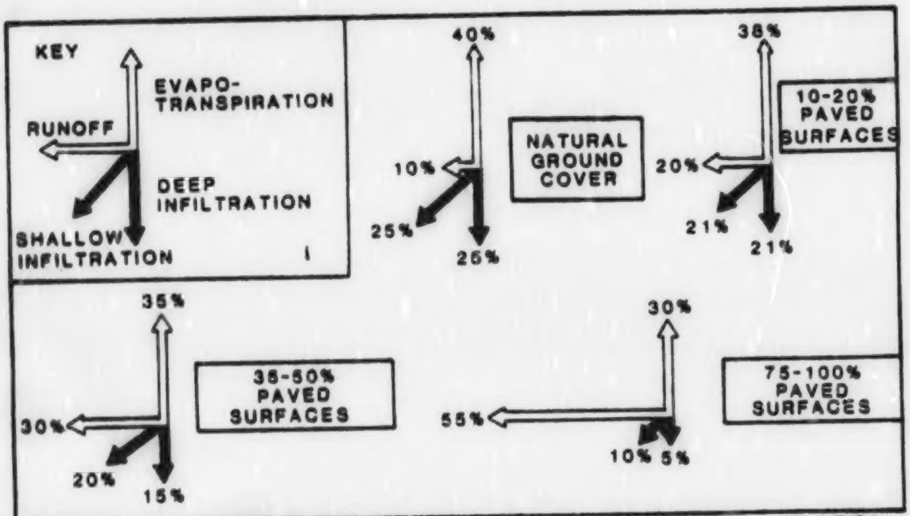

KEY
EVAPO-TRANSPIRATION
RUNOFF
DEEP INFILTRATION
SHALLOW INFILTRATION
40%
10%
25%
25%
NATURAL GROUND COVER
38%
20%
21%
21%
10-20% PAVED SURFACES
35%
30%
20%
15%
35-50% PAVED SURFACES
30%
55%
10%
5%
75-100% PAVED SURFACES

FIGURE V-3 HYDROGRAPH CHANGES DUE TO INCREASING THE AREA OF IMPERMEABLE PAVED SURFACES - ROOFS, ETC. IN A DEVELOPED AREA (HO-310)

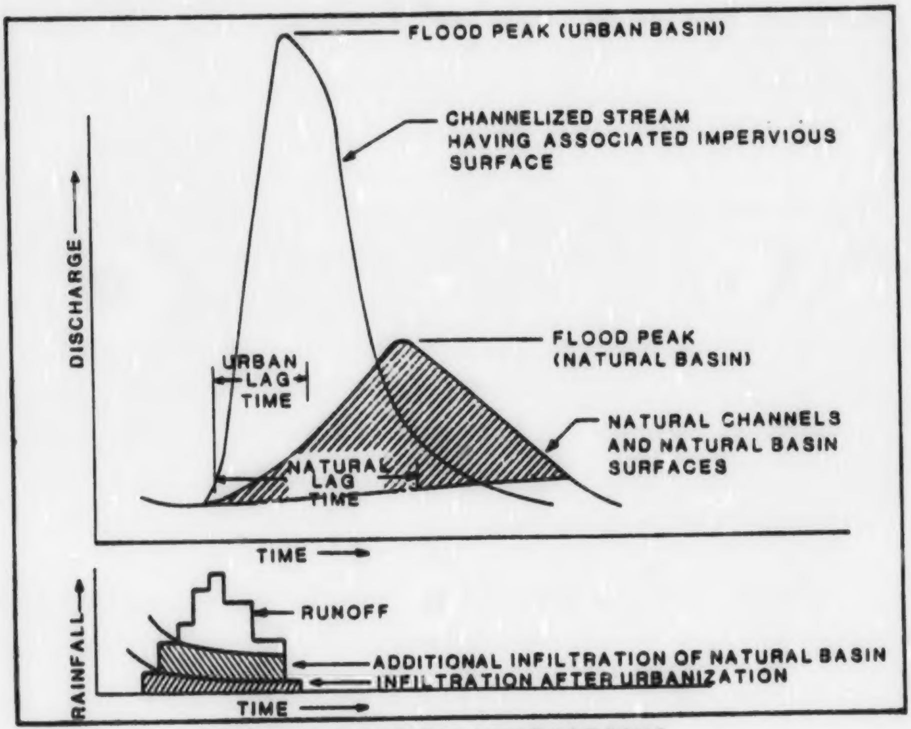


FIGURE V-4 TYPICAL HYDROGRAPHS FOR URBAN AND NATURAL WATERSHEDS (PU-050)

	Degree of Development (Percentage Impervious Cover)		
	None	25	50
Basin Lag Time (hours)	2.03	0.30	0.22
2-Year Flood Peak Discharge (cfs)	85	269	323
25-Year Flood Peak Discharge (cfs)	380	852	970
100-Year Flood Peak Discharge (cfs)	654	1230	1370

Source: PU-050

As seen from this table, when 50 percent of the drainage area is impervious, the discharge of the 100-year flood increases more than 100 percent above that of a natural basin. The cause of this increased flood peak is a nine-fold reduction in the basin lag time.

The channelization of South Buffalo Creek is an attempt to accommodate these higher flows from urban areas that exceed the capacity of the natural stream. Channelization, beyond its aesthetic degradation, has other adverse impacts, such as increased erosion from higher velocities and increased flooding downstream of the channelized reach. Other better (i.e., more environmentally sound) methods exist to mitigate the hydraulic effects of urbanization (Chapter VI), but they are less direct and less implementable than channelization projects.

The more intensive urban development of the Greensboro area promoted by the proposed action will generally translate into more channelization-type and flood-prevention projects as an indirect effect. Peak flows will continue to increase in both magnitude and frequency on watersheds experiencing continued urbanization. The effects of this increased flooding are discussed in the Land/Water Interface Section of this chapter while appropriate mitigating measures are identified in Chapter VI.

(b) Stream Quality

The principal reason for implementing the proposed action is to improve the wastewater treatment capability of the City of Greensboro and consequently to enhance the water quality of the area's receiving streams. Such enhancement may be either direct (e.g., reducing pollutant loads by better treatment) or indirect (e.g., by providing a large buffer against non-point source pollution). The streams, while small, receive substantial and varied pollutant inputs from industrial as well as municipal sources. The exact nature and source of non-municipal discharges are currently unknown; efforts are underway to institute monitoring programs for identifying point-source dischargers and the effluent quality. The chief pollutants subject to control at the municipal wastewater treatment plants are oxygen-demanding material of carbonaceous and nitrogenous origin, suspended solids, and pathogenic bacteriological species. Not all of these are being adequately controlled currently to protect instream quality (NO-111). However, there is also considerable evidence that other water quality parameters not subject to control at the municipal plants may be ecologically as important in these streams. These parameters include heavy metals, other minor chemical species such as fluoride, and even color. These constituents derive from industrial point sources and non-point sources. The direct and indirect effects on the water quality of area streams must be viewed in light of all these factors, as dictated by the "water quality-limited" status of these streams. However, for purposes of organization, the various water quality aspects are addressed separately in the following subsections on siltation, dissolved oxygen, fecal coliform bacteria, nutrients, residual chlorine, and indirect effects related to urbanization.

Siltation

Construction activities for the North Buffalo plant improvements, the new South Buffalo plant, and especially the major outfall sewers have potential for degrading water quality with suspended and bedload solids from erosion of disturbed material. Only a small amount of construction will be required at the North Buffalo site and all disturbance will be within the flood-protection berm. This should enable effective sediment control. The South Buffalo plant, while situated on fairly erosive soils, has adequate space and topography for effective sediment controls (NO-139). A large vegetative buffer also exists to trap any sediment-laden runoff that should escape controls at the site. Any siltation of South Buffalo Creek as a result of treatment plant construction is consequently expected to be temporary, minor, and of no consequence. However, the construction of the outfall sewer from the existing South Buffalo plant downstream to the proposed site has the potential for significantly increasing the sediment loads to South Buffalo Creek. This outfall sewer will parallel the creek for about five miles and cross six tributaries. The ground cover on approximately 60 acres of land will be disturbed and will demand rigid adherence to the erosion and sediment control plan required by the state (NO-139) to minimize the siltation. Owing to the high velocities in the channelized reach, this sediment is likely to be transported fairly rapidly to more downstream areas where the hydraulic gradient is smaller. Buffalo Creek and Reedy Fork below their confluence will be likely indefinite residence areas for this eroded material. It seems very doubtful that such sedimentation could achieve any useful purpose (e.g., increasing reaeration) and more likely that the sediment would impose a threat to any aquatic biota through the reaches affected.

Dissolved Oxygen

Maintenance of a satisfactorily high dissolved oxygen (D.O.) content is critical to aquatic biota and also important in maintaining a chemically oxidizing overall environment to prevent formation of noxious, often malodorous compounds that are usually a result of anaerobic degradation. In wastewater treatment, dissolved oxygen resources in a receiving stream are protected by removing oxygen-demanding material from the wastewaters and also by charging the wastewaters with dissolved oxygen before discharge. The North and South Buffalo Creek plants are currently discharging BOD loads of 1460 pounds per day and 2800 pounds per day, respectively. At the design discharge, which is nearly double the existing hydraulic loading, the BOD loads to North and South Buffalo Creeks from these plants will be reduced to 800 pounds per day and 1840 pounds per day, respectively. Qualitatively, then, although more treated wastewater will be entering the streams from the municipal treatment plants, less pollutants will be discharged to the creek. Ultimately, this improved effluent will be reflected by better stream quality with respect to dissolved oxygen.

In order to predict what levels of dissolved oxygen will actually exist in these streams under standard worst-case conditions, several mathematical models were employed to simulate the streams' responses. Much more and better input information is available for the North Buffalo than for the South Buffalo system, so the level of sophistication and confidence in the results is higher on North Buffalo. This modeling was accomplished by the State of North Carolina Division of Environmental Management in the course of allocating suitable waste loads for the assimilative capacity of the receiving streams and independently appraised by an EPA contractor. The influence of all discharges to a given receiving stream must be considered because the superposition of waste loads tends to be cumulative in its effect on stream quality, although dilution by the wastewaters themselves can be an important modifying factor. Details concerning the modeling can be found in the Technical Reference Document (RA-R-406). Because the two receiving streams and their waste inputs were modeled in structurally different ways, they are discussed separately.

North Buffalo Creek, Buffalo Creek, and Reedy Fork were considered as a principal hydrologic system. Primary wastewater discharges to this system are Cone Mills, North Buffalo sewage treatment plant, and the wastewater-dominated South Buffalo Creek. The D.O. profile along this stream system after wastewater improvements at the North Buffalo plant is shown in Figure V-5. As shown, a double "sag" is predicted, one below the North Buffalo plant and one below South Buffalo Creek, but the D.O. never drops below the stream water quality criterion of 5.0 mg/ℓ. It must be recognized, however, that this predicted absence of contravention of the stream standard depends in both sag areas upon other conditions which currently do not exist. A major mill is assumed in the model to meet its effluent limitations, but achievement of this mandate has yet to take place (enforcement of water quality standards may be necessary to ensure compliance with this mandate). In addition, the waste load input by South Buffalo Creek assumes a substantially improved condition over that which now exists and possibly over that which may exist even after improvements to the municipal system in that basin (see discussion below). It must also be pointed out that the modeling does not include the oxygen-demanding materials from distributed or non-point sources which may be periodically substantial in a highly urbanized basin such as North Buffalo Creek. Generally then, the dissolved oxygen resources in North Buffalo Creek and its downstream waters at least as far as the Reedy Fork-Buffalo River confluence will be only marginally adequate to support fish and wildlife and other uses of this stream, even after the proposed action. In consideration of other water quality constituents that may act synergistically with this stress, the water quality in this hydrologic system is likely to remain in a poor state during some flow conditions for an indefinite period. It appears to be technologically (or at least economically) unfeasible now to treat the municipal wastewaters to a level sufficiently high to avoid this conclusion. It should be realized, though, that the high level of treatment

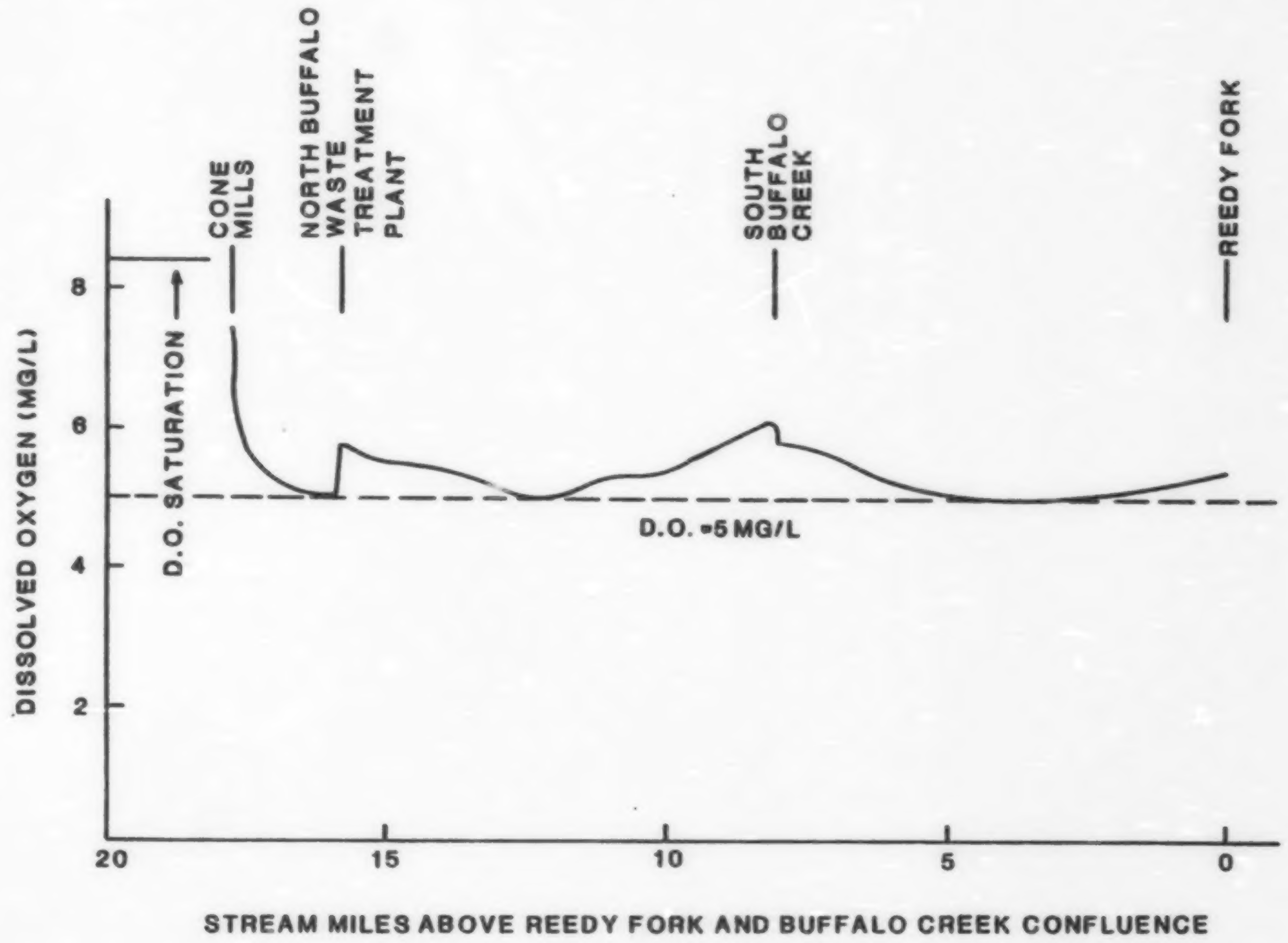


FIGURE V-5
NORTH BUFFALO AND BUFFALO CREEK
DISSOLVED OXYGEN PROFILE

at the municipal plant affords longer time periods when the water quality in the creeks will be suitable for its intended uses.

The South Buffalo Creek water quality has been addressed in a less sophisticated fashion, owing to an apparent lack of adequate information on industrial discharges and their effect on the stream quality. With the proposed South Buffalo Creek plant site, the effects of these industrial discharges have been assumed to be negligible at this downstream location. This assumption is not currently realistic, but there is reason to consider its applicability after available control technologies or water/wastewater recycling are applied to the industrial point sources. The D.O. profile along South Buffalo Creek below the outfall of the proposed new plant, shown in Figure V-6, suggests that under these conditions the stream D.O. criterion can be met. However, both the effects of inadequately treated upstream discharges, transmitted rapidly to the proposed new plant in the channelized portion of the creek, and the effects of non-point sources as urbanization of the basin proceeds are almost certain not only to cause a continuation of the poor quality now existing in South Buffalo Creek, but also to extend the area stressed in a more downstream direction. The severity of the stress should be less than with the existing plant location, which will likely prevent anoxic conditions from developing over large reaches of the stream during critical periods. Again, the water quality conditions that will be experienced in the South Buffalo basin are principally a function of the small size of these headwater streams which receive substantial point source and non-point pollutant loads. Under projected conditions, little benefit could be derived from increasing the level of treatment at the municipal plant even if cost was a minor consideration.

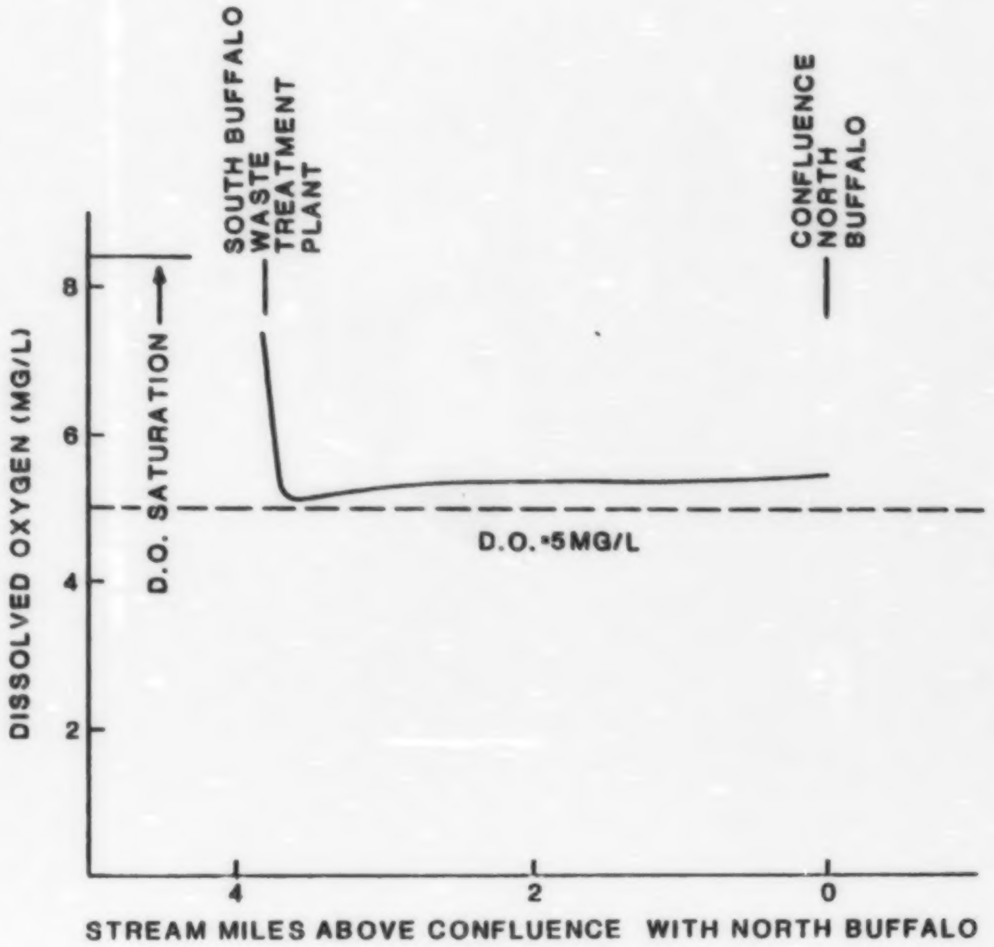


FIGURE V-6
SOUTH BUFFALO CREEK
DISSOLVED OXYGEN PROFILE

It should be recognized that the proposed action will remove the wastewater currently discharged at the existing plant for about five miles downstream. Under low flow conditions, little dilution and less reaeration will be available to counter oxygen demand of the industrial wastes discharged upstream. Consequently, the removal of this municipal waste source is not tantamount to improved stream quality in that reach.

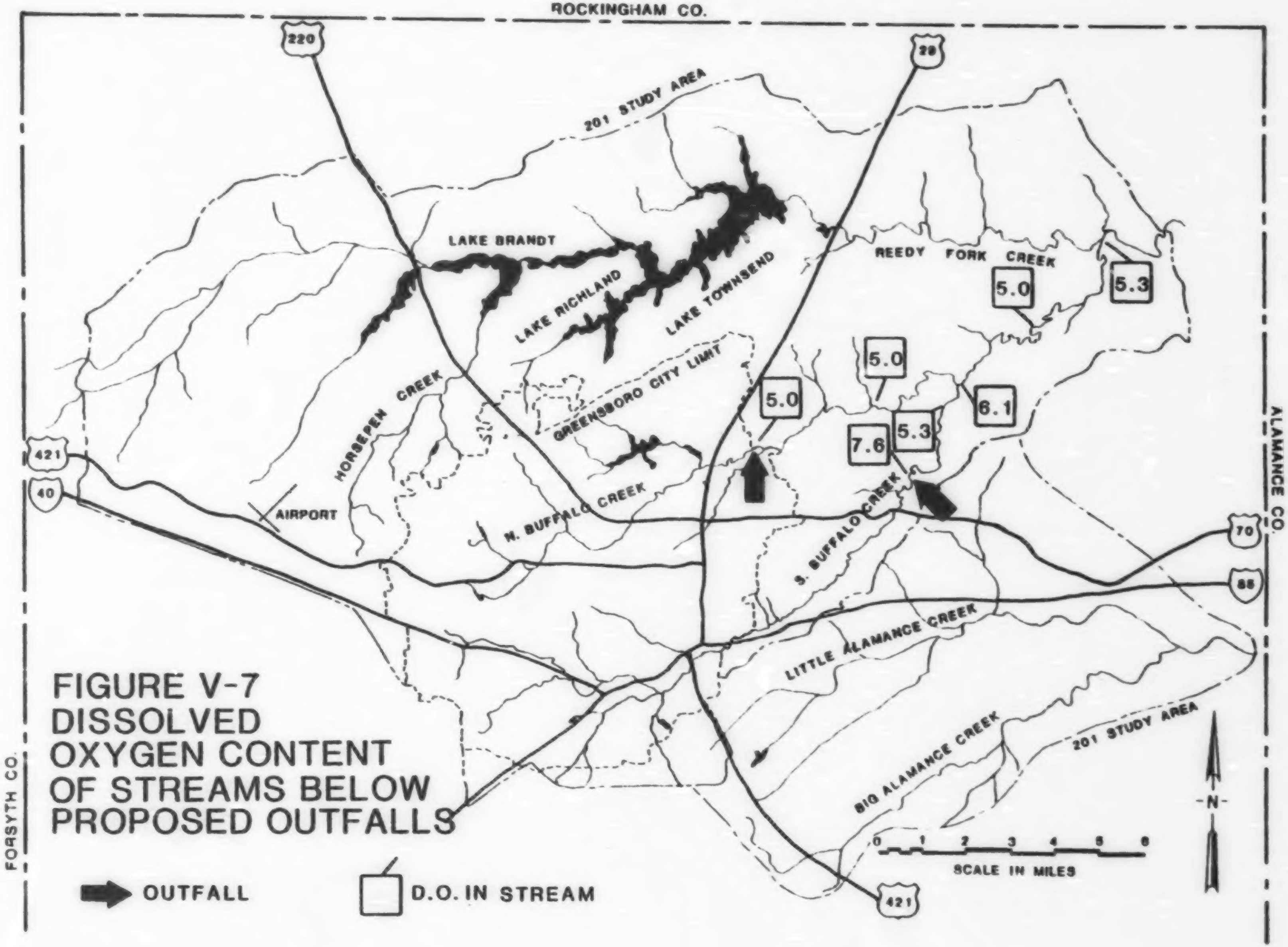
The map in Figure V-7 shows values of dissolved oxygen in area streams at selected locations. These D.O. values would be near-minima that could be reached during very low flows and that result from point source discharges after the proposed action is implemented. There appears to be little question that the assimilative capacity of these streams is being approached and that alternate receiving streams should be considered in the future. Implementation of the proposed action will likely most significantly improve the water quality in the lower reaches of Buffalo Creek and below the confluence with Reedy Fork and maintain water quality in more downstream areas.

Fecal Coliforms

The wastewater treatment plants and other components of the proposed action are to be designated Class I[1] reliability systems. This rating assures that design features, operational procedures, and materials will be provided to offer a high degree of protection against major plant malfunctions. Nevertheless, remote pumping station bypassing, treatment plant malfunctions, or operator error could result in discharge of untreated or very poorly treated sewage. Such discharges are possible and have occured in similar plants in the past. In this extremely unlikely event, public health would be the chief concern. A public health

---

[1] Class I - The highest level of sophistication available for insuring reliable waste treatment within the present state of the art of wastewater engineering technology (EN-610).



ROCKINGHAM CO.
ALAMANCE CO.
FORSYTH CO.
220
29
421
40
70
85
421
201 STUDY AREA
LAKE BRANDT
LAKE RICHLAND
LAKE TOWNSEND
GREENSBORO CITY LIMIT
REEDY FORK CREEK
HORSEPEN CREEK
AIRPORT
N. BUFFALO CREEK
S. BUFFALO CREEK
LITTLE ALAMANCE CREEK
BIG ALAMANCE CREEK
201 STUDY AREA
5.0
5.3
5.0
6.1
5.0
5.3
7.6
0 1 2 3 4 5 6
SCALE IN MILES
N
OUTFALL
D.O. IN STREAM

FIGURE V-7
DISSOLVED OXYGEN CONTENT OF STREAMS BELOW PROPOSED OUTFALLS

hazard to water-contact recreation would exist for no more than about 44 miles downstream of any potential discharge point based on uncalibrated modeling of the coliform die-off under worst-case conditions. No Class "B"[1] or higher water exists within 44 miles downstream of either treatment plant. Pumping stations, and especially any pumping station in the Horsepen Creek basin, appear to be a larger possible hazard although the magnitude or significance of the effects can range from very small to extensive. Potential actions to mitigate this hazard are discussed in Chapter VI.

An important water quality aspect of the proposed action which should improve normal and low flow bacteriological quality is the sewering of areas within the South Buffalo basin that currently generate local stream pollution by poorly sited, operating, or maintained septic tanks. Extremely high fecal coliform concentrations in South Buffalo Creek that have occurred in the past should be reduced, although re-occurrence of this pollution problem can be expected in areas peripheral to the sewered area without mitigative measures. Moreover, storm runoff will continue to contribute large numbers of coliform bacteria to all area creeks.

Nutrients

Neither treatment plant will undertake nutrient removal, and the nitrification step in the unit processes employed essentially guarantees that the nitrogen will be in a generally available form as nitrate. Despite the relatively high concentrations of these nutrients in the wastewater effluent and even in the receiving stream, no adverse effects on water quality are associated with the nutrients because, in these streams, these nutrients (and carbon) are almost certainly not limiting to biological growth.

---

[1] Class B - Waters suitable for water-contact recreation such as swimming, wading, or skiing.

Turbidity, caused by intense color and suspended sediment, is probably much more important in controlling growth, and in the immediate area, the presence of industrially generated toxic substances, such as ammonia, fluoride, and certain heavy metals, have inhibited better trophic conditions in the past. It is not known whether and the extent to which many of these limiting or inhibiting factors have been controlled in the past few years. In any event, however, nutrients are probably not a control on water quality in these small, unimpounded receiving streams.

Residual Chlorine

Efficient disinfection of municipal wastewater requires sufficient chlorine to meet the complete chlorine demand plus an additional quantity, termed residual chlorine, to provide bacterial disinfection. Under commonly encountered operating practices where economics generally dictate, chlorine will be present in toxic amounts for only a short period of time after contact with organic material and other reducing substances in the effluent. Residual chlorine concentrations in the treated effluent should be negligible. Disinfection usually is accomplished before the outfall and within the mixing zone. Any residual chlorine will be diluted and normally disappear within a few tens of feet of the outfall in the receiving stream. Chlorine is not expected to be a significant ecological burden on any of the receiving streams. The short residence time and the relatively low concentration of the chlorine relative to drinking water treatment should alleviate most concern for the inadvertent formation of chlorinated hydrocarbons, some of which are carcinogenic. However, the probable presence of a wide variety of organic compounds of industrial origin in both the municipal wastewater and the receiving waters of North and South Buffalo Creeks is incentive to maintain a monitoring program for trace organics in the effluent. No plans for such monitoring are known to have been formulated.

Secondary Effects

The proposed action will encourage more intensive urban land use and promote more extensive growth in the Greensboro area than would exist without the project. This change will directly affect stream water quality because drainage from urban areas typically is of poor quality with substantial, unacceptably high amounts of suspended solids, pathogens, oil and grease, oxygen-demanding material, nutrients, and toxic substances (pesticides, herbicides, and heavy metals). This quality generally worsens, then improves with time during a storm event, and the total mass and concentration of a given pollutant that reaches a stream depends on a multiplicity of factors. Other factors being equal, however, generally non-point source pollutant loadings may be compared at a first approximation level on an areal basis. During a given time interval, the increase in pollutant loadings (not necessarily concentrations) are approximately proportional to the increase in urbanized areas of the various basins. Very large percent increases in urbanized area may generally be assumed to be accompanied by increased concentrations of the pollutants as well, although there are many complicating factors. Therefore, the streams whose water quality is most likely to be degraded relative to existing conditions are those basins and subbasins in the transition areas. This increase in area adversely affected by urban runoff is an attendent impact of urban growth if such growth is not properly planned and controlled. The marginal condition of water quality created by the point-source discharges in the study area underscores the potential important role urban runoff can play in water quality degradation of streams in the Greensboro area and in the maintenance of some streams in a degraded state despite improvements to point sources.

The EPA and State of North Carolina are sponsoring an ongoing study to quantify more accurately the potential secondary water quality effects of typical urbanization characteristic of the Greensboro area. Results of this study, however, are not available to this Draft EIS. The program is explained in more detail in the following subsection on reservoir quality.

Reservoir Quality

The extension of sewer service into the Horsepen Creek watershed has the potential to encourage development and therefore degrade the quality of runoff into the Greensboro water supply (i.e., Lake Brandt). However, without the sewer interceptor, development is projected to occur in the Horsepen Creek watershed by use of septic tanks. Septic tank failures and malfunctions pose a public health hazard by increasing the chance of contamination of the water supply with pathogenic organisms while urban runoff contributes unacceptable levels of other deleterious substances as discussed under stream quality. Therefore, management of the Horsepen Creek watershed to minimize these pollutant loadings is a necessity to insure protection of the Greensboro water supply. Development of this management plan should be based on both a water quality data base for the area streams and lakes and on sound judgement where appropriate. For this reason, a water quality monitoring program has been initiated and will be used in the environmental assessment of proposed development scenarios in the Horsepen Creek Basin. This program is currently in progress and therefore the results cannot be included in this Draft EIS. However, the findings of the study and a proposed action with possible mitigating measures for unavoidable impacts will be included in a supplement to the Draft and in the Final EIS. The following describes the ongoing monitoring program.

Three area watersheds were selected for extensive monitoring during both low flow and storm runoff. Transient hydraulic response and major, minor, and trace inorganic species are being studied in all three basins. The first of these watersheds, Horsepen Creek, is being sampled during high and low flows at Fleming Road to define the existing pollutant loads to Lake Brandt. The goal of the monitoring program is to project changes in this current loading associated with the two development scenarios (i.e., septic tanks or sewered). In addition to Horsepen Creek, two additional watersheds are being monitored. To define the quality of water associated with a sewered watershed, North Buffalo Creek is being sampled near the headwaters at Friendly Road. This basin is now predominantly single-family residential and is served by the Greensboro sanitary sewer system. The basin contains several stormwater detention ponds and a significant amount of open space. Two low flow periods and two storm runoff events will be sampled at this site. The data collected at this site will be used to estimate pollutant concentrations and total mass loads from a typical Greensboro residential watershed.

To define water quality changes associated with septic tank development, Cedarwood subdivision, located south of Horsepen Creek on High Point Lake, is also being sampled twice during low flow periods. The subdivision is developed with septic tanks in a soil type (Enon series) that is similar in suitability for septic tanks to soils in the Horsepen Creek Basin and has similar land use to that which potentially could exist in Horsepen Creek Basin.

In addition to the stream sampling, Lake Brandt is also being sampled at three stations following storm events sampled on Horsepen Creek. Additionally, Lake Brandt will be sampled during mid-summer to define the effects of stratification and a nutrient mass balance. This information will provide data on the overall trophic state of Lake Brandt and input data for an areal loading model to predict lake performance under the loadings of the various urbanization scenarios. The model to be used is the Larsen-

Mercier model that accounts for nutrient retention on lake sediments as well as nutrient uptake by biota in the inflow-outflow balance. Phosphorus will be the nutrient of principal interest.

(2) Ground Water

The ground-water conditions at the proposed new treatment plant site are typical of the Piedmont environment in the Greensboro region. Ground water occurs in the fractures of the hard metamorphic and igneous bedrock. Recharge to the aquifer occurs in the uplands, and ground water is discharged into the streambed and alluvium of South Buffalo Creek.

The greatest potential ground-water impact is the possible water quality hazard posed by leakage from facilities at the treatment plant site. This hazard is most significant for those facilities that are emplaced below the soil zone. However, any contaminated water that goes into the subsurface should be at least partially renovated in the zone of aeration. Furthermore, any ground water that is contaminated would be restricted to the immediate vicinity of the proposed site. Contaminated ground-water flow would be from the site toward South Buffalo Creek, so no water supply sources will be affected.

Another potential ground-water quality hazard is the nearly five-mile-long raw sewage pipeline that will lead from the existing South Buffalo treatment plant to the new treatment plant site. However, as with all sewers and force mains in the system, leakage and ground-water quality reduction should be minimal if good, up-to-date engineering practices that will prevent pipeline leakage are used in the pipeline construction. Also, the alluvial aquifer is small and very little used, so no major source of water supply is involved.

The expansion of the North Buffalo treatment plant is expected to have very little impact on ground-water systems. The additional flow in North Buffalo Creek may raise ground-water levels in the alluvial aquifer, but this impact is insignificant. Potential leakage from the additional facilities may deteriorate local ground-water quality, but this effect will be very local and no water supply source will be affected.

The increased urbanization associated with the proposed project will increase ground-water withdrawals by residences which are not included in the Greensboro water supply system. The amount of withdrawal is not expected to result in aquifer depletion, however, because the quantity withdrawn annually will not approach the annual recharge to the aquifers. If as much as 30% of the increased population of 90,000 were to rely on ground-water supplies, the 2.7 million gallons per day (MGD) demand could be accommodated by ground-water recharge in the area of urbanization. The total quantity of ground water available in Guilford County is about 150 MGD (see Chapter II), so the quantity available in the area of urbanization should exceed 2.7 MGD. Some recharge will be lost because of "paving over" of part of the land during urbanization, but water levels should not decline as a result. However, a portion of baseflow to streams will be lost as a result, but this loss will be insignificant compared to the existing flow from artificial discharges.

g. Land/Water Interface

Continued urbanization of previously undeveloped areas within watersheds draining the Greensboro area will continue to increase flood flows and correspondingly raise the floodplain elevation of affected creeks. This increase in flooding can be directly related to the level of development expressed as the percent of impervious cover. The U.S. Geological Survey has developed regression equations based on impervious cover to predict the peak discharges of various streams for a given recurrence interval (e.g., 100-year storm) (PU-050). Utilizing these equations, the lag time is determined for a given set of known watershed conditions such as stream slope, stream length, and percent of impervious cover. Once the lag time is determined, the corresponding peak discharge can be determined knowing the drainage area. Assuming all other basin characteristics remain the same, a corresponding peak discharge can be determined for appropriate changes in impervious cover. In order to relate the peak discharges obtained in this manner to the corresponding floodstage, a stage-discharge relationship is needed. This relationship has been established at several sites on various streams throughout the Greensboro area at U.S. Geological Survey stream gages.

To illustrate the changes in flood elevations as a result of increases in impervious cover, the regression equations were solved for various percentages of impervious cover where North Buffalo Creek crosses Highway 2832. The results are shown in Table V-8. Although the increases in flood elevations experienced at this site are not representative of all streams in the Greensboro area, they do show how urbanization significantly increases flood levels.

TABLE V-8

CHANGES IN FLOOD ELEVATIONS AS A RESULT OF INCREASES IN IMPERVIOUS COVER

PERCENT IMPERVIOUS COVER	100-YEAR PEAK FLOW (cfs)	CHANGE IN FLOOD ELEVATION ABOVE 1% IMPERVIOUS (ft)
1	5,000	0
5	6,900	2.1
10	7,800	3.1
20	8,900	4.1
40	10,000	5.1
60	10,600	5.6

These increased flood levels will expose land previously not subject to flooding to high velocity waters, thus increasing the erosion potential of previously unflooded areas. This increased soil load will be carried downstream until the stream velocity slows enough to deposit the additional sediment. Some previously unflooded areas will experience this increased erosion while other previously unflooded areas will experience the increase in sedimentation. As these projected increases in flooding from urbanization will occur gradually with time, the impacts to the flood-prone areas are expected to be gradual and mostly minor with respect to the natural environment.

However, man-made developments bordering the existing floodplain will need to take costly flood protection measures if urbanization of watersheds continues. Measures to both minimize the increases in flooding associated with urbanization and to protect existing developments in projected floodplains are identified in Chapter VI.

2. Biological Components

a. General

The environmental effects of the proposed action on terrestrial and aquatic biota in the Greensboro area must be evaluated with regard to the existing condition of these communities. Short-term direct effects will stem from construction at plant sites, pump stations, and along pipeline routes. Direct effects of longer duration will be caused by operation of the new facilities. Indirect effects will occur as a result of urbanization in newly sewered areas. It is assumed, however, that this growth would occur with or without the proposed action.

b. Land

Construction of facilities for upgrading the level of treatment at the North Buffalo sewage treatment plant will occur within existing plant boundaries. The grounds of the plant are covered with coastal bermuda and mowed. Therefore, no significant disturbance of natural plant communities by construction will occur in this area. Some small rodents and snakes which presently inhabit the existing plant site will be destroyed during construction. Birds and small mammals that utilize these grassy areas for feeding will temporarily leave because of construction noise and increases in human activity. These species, such as starlings and cottontail rabbits, will return during and after construction.

The construction of a new sewage treatment plant at the proposed site on South Buffalo Creek will remove about 40 acres of improved pastureland and mixed pine-hardwoods. The removal of trees will not be significant because the proposed site is essentially all pasture. Only a few large oak and maple trees that stand near abandoned dwellings will be removed. The monocrop community of improved forage grass in the pastures at the site is non-native. Therefore, its removal and replacement by a monocrop community of coastal bermuda grass will have only minor, temporary effects on existing plant communities.

Terrestrial wildlife species at the proposed site are those common to improved pastures and abandoned buildings. Rice rats, white-footed mice, meadowlarks and common ground snakes are the types of animals that will be destroyed during construction at the site. The small number of individuals removed will not have a serious impact on local populations. Other species not removed by construction will withdraw from the immediate construction area because of noise. Traffic on heavy equipment and truck access roads, blasting, engine noise, dust, and generally increased levels of human activity during construction will cause wildlife inhabiting upland mixed pine-hardwood habitats at the periphery of the site to temporarily move further into this cover. Some species, such as eastern fox squirrels and cottontail rabbits, will habituate to these disturbances and return to the periphery of the site before construction is completed. Others, like raccoons or oppossums, will forage in and around the site nocturnally. Species more intolerant of human disturbance will return to the vicinity of the site after construction is complete. Because of the rural character of the area, most species utilizing available habitats around the site are those accustomed to some level of human disturbance. Therefore, the effects of noise from construction and operation of the new plant on resident species are expected to be slight and temporary.

The proposed construction of a 26,000-foot outfall sewer down South Buffalo Creek from the existing South Buffalo sewage treatment plant to the proposed new sewage treatment plant on South Buffalo Creek will disturb about 60 acres of riparian biota (assuming a 100-foot right-of-way). The loss of riparian woodlands along this route will be minimized because about 25,000 feet of this creek segment has been previously channelized. Along the majority of this segment, the only ground cover within 20-30 feet of the streambank is low-growing grasses, herbs, and shrubs. This same ground cover will revegetate the streambank after construction is complete. Because the majority of the riparian vegetation along this stream segment is presently disturbed, no lasting adverse effects on riparian vegetation are anticipated.

Wildlife which presently utilize the disturbed riparian habitat along the proposed outfall route will temporarily withdraw from the noise and general human disturbance which accompany construction. Nesting sites or activities of some riparian birds and mammals will be destroyed or interrupted by construction, especially if construction takes place during the spring. A few individuals, such as leopard frogs, ribbon snakes or golden mice, will be killed as a direct result of construction. Removal of these animals will not have any lasting effect on area populations. Because construction will proceed in a linear fashion down the creek, only a relatively small area will be disturbed at any given time. Those species which leave these areas because of construction disturbance will return after completion of the outfall and revegetation of the creek banks.

Operation of the new plant on South Buffalo Creek will not have any lasting effect on area wildlife. Plant noise, vehicular traffic, and increased human activity will disturb resident wildlife only temporarily. Most species will habituate to these disturbances relatively quickly.

The indirect environmental effects of the proposed action on terrestrial flora and fauna will stem from urbanization in newly sewered, previously rural, areas. Fragmentation of existing wildlife habitats will increase. Native vegetation will be replaced with urban species and wildlife will withdraw from the expanding city limits due to increased human disturbance and loss of suitable habitat.

c. Water

The effects of construction at the existing North Buffalo sewage treatment plant and at the proposed new sewage treatment plant site on aquatic biota will be comparatively minor. Both streams presently afford poor habitat for aquatic life. Therefore, temporary siltation and/or runoff associated with construction will not adversely affect the aquatic environment downstream. Two small farm ponds at the new treatment plant site on

South Buffalo Creek contain reproducing populations of largemouth bass and sunfish. Siltation of both ponds is likely during construction and will probably interfere with fish reproduction for one or two seasons. The smaller of the two ponds will be destroyed during construction. Loss of this fishery will have no impact on local recreational fishing because public access is restricted. The remaining larger pond might be used for public fishing when construction is complete.

Construction of the 26,000-foot outfall sewer in, across, and on the banks of South Buffalo Creek will further disturb a segment of the creek that has been previously channelized. Aquatic habitat quality in this segment is poor. Adverse effects associated with construction, such as siltation or channel diversion, will be temporary and will not significantly degrade existing conditions.

Operation of the upgraded facilities will result in the discharge of a comparatively high quality effluent to both receiving streams. Dissolved oxygen levels downstream of both sewage treatment plant discharges will not fall below 5 mg/ℓ according to design criteria. Total suspended solids concentrations will also be reduced. These improvements in wastewater quality will be reflected instream only if point source discharges upstream of both sewage treatment plants are of higher quality than now. Additionally, the long history of municipal and industrial pollution of North and South Buffalo Creeks makes improvement of aquatic habitat quality unlikely for an indefinite period. Sewage treatment plant upset or inefficiency during the winter, discharge of industrial effluents upstream, and urban runoff will continue to inhibit the growth of aquatic life. Neither stream will become an important sport fishery as a result of implementing the proposed action.

Nitrogen and phosphorus loading of both streams will continue because these elements will not be removed from the treated effluent at either facility. Nitrogen will be removed to some extent due to the use of advanced treatment. Algal blooms or increases in undesirable rooted aquatic plants have not been problematic in either stream in the past. High flow rates, turbidity, and an unstable substrate will continue to inhibit plant/algal growth during the design period.

Increases in flow which will occur downstream from both plants during the design period will be similar to those observed in both streams in the previous 20 years, and discharge increases will occur gradually. Flows downstream of the confluence of the two creeks will increase from a present average of 19.6 MGD to 36 MGD. The biota that remain in both streams have been subjected to similar historical increases in flow as well as bottom scouring associated with large flood flows. The banks of both streams will continue to be gradually cut and the slumping now observed in some stream segments will continue. Where the streams are not now channelized, some trees will fall into the streams as the banks erode. This erosion will cause some sedimentation and turbidity similar to that presently observed.

Flow in the 26,000-foot segment of South Buffalo Creek below the existing sewage treatment plant will be decreased by about 10 MGD when the plant is closed. Average natural flow in this segment is greater than 13 MGD 50 percent of the time. When the 10 MGD of treated effluent is withdrawn, flow in this segment will be chiefly composed of urban runoff and industrial effluent. Aquatic habitat quality will be poor as a result; however, existing habitat quality is poor and the aquatic flora and fauna depauperate. Therefore, though water quantity and habitat quality will be reduced in this segment, the change in the biota that remain will be small.

Urbanization in the watershed of both North and South Buffalo Creeks will cause indirect project-related effects over the next two decades. Increases in urban runoff will contribute to maintenance of the present low quality of aquatic habitats observed in both streams. During seasonal low flows, urban runoff will have a more pronounced effect on aquatic habitat quality because of the low dilution capacity of receiving streams.

d. Sensitive Biological Areas

No rare/endangered terrestrial plant or animal species or habitats critical for such species are currently known to occur at either sewage treatment plant site or along the proposed pipeline route. All of these areas have been previously disturbed by man's agricultural or residential use. There are no tracts of virgin woodland, nor are there specific habitat types which will be permanently removed. Aquatic biota in North and South Buffalo Creeks are currently largely composed of pollution-tolerant species. No rare/endangered species or quality habitats have been found in either creek.

C. Man-Made Environment

The proposed action will cause changes to occur in the man-made environment at two levels. First, there will be direct impacts which will be associated with (1) the work force required for construction and operation of the proposed action and (2) the effects on people living and working near the various components. Second, the expanded sewage treatment capacity will affect the EIS Study Area in an indirect manner as the area grows in population. Each of the major factors to be considered in the man-made environment will be addressed from these two perspectives so that the consequences of the proposed action can be understood.

1. Demography and Economics

Demographic effects are those related to the population of an area. The major problems which may arise, either in the short-term or long-term, will manifest themselves in (1) change in population size, (2) change in demographic characteristics (age, sex, race, etc.), or (3) change in geographic distribution.

Economic effects are related to changes in the structure of the economy and to changes in employment. The structure of an economy can range from one which is extremely dependent on one type of industry, such as textile manufacturing or educational services, to one as diverse as the national economy. Changes in total employment and unemployment reflect overall business activity.

a. Direct Impacts

The only component of the system which might cause a movement of population is the new South Buffalo plant. The North Buffalo plant will be upgraded within its existing boundary so that none of the surrounding population will be displaced. The outfall from the old South Buffalo plant to the new site will be a temporary inconvenience, but its presence will not require people to move.

The new South Buffalo plant will be built on a vacant farm. None of the land to be purchased as a buffer zone has occupied housing units. Therefore, the new plant will not require the relocation of population. In addition, the number of people who may be aware of the plant's existence is relatively small. As Table V-9 shows, only 90 people, approximately, live within 3000 feet of the plant perimeter. All these people live more than 2000 feet from the proposed facility.

TABLE V-9

INHABITANTS WITHIN RADIUS OF:

	1,000'	2000'	3000'	Total
North Buffalo	42	716	1181	1949
Existing South Buffalo	43	878	2272	3192
New South Buffalo	0	0	90	90

The construction and operation of the proposed action will not cause a significant growth in the population of the area. An average of 30 people, with a maximum of 50 at any one time, will be employed in the 2½-year construction period. This is a relatively small number when it is considered that Guilford County has nearly 7000 unemployed people.

The operation of the expanded system will probably require several additional employees in the Greensboro Public Works Department. Currently, 24 people are employed at the North Buffalo plant and 17 are employed at South Buffalo. The upgraded North Buffalo plant will require an additional 16 employees.

The people now operating South Buffalo will probably be transferred to the new South Buffalo facility. Twenty-eight additional people will be required to operate the new plant. Again, this is a very small number and the workers are probably available from the existing labor supply.

Direct economic effects will result from (1) the increase in purchasing by the construction and operation work force, (2) the sale of materials for the construction and operation, and (3) the sale of land for the South Buffalo site. In the first case, the wages and salaries for the construction will amount to approximately $1,900,000, assuming $15,000 per worker. If forty-four new employees are added to the Public Works Department staff as a result of the proposed action, approximately $528,000 in wages and benefits, assuming $12,000 per worker per year, will be added to the area payroll.

Second, the cost of materials will be approximately $20 million. Much of the material will be purchased locally. Finally, the City of Greensboro will purchase approximately 400 acres for the new South Buffalo plant.[1] Property values near the South Buffalo site may decline somewhat in the short term. However, proximity to Greensboro and eventual access to sewage treatment should keep the values from falling precipitously. Values may even increase because of the increased potential for industrial and residential development.

Of the final $33.3 million for the proposed action, North Carolina and EPA funds will provide 87.5%. Hence, the EIS Study Area will be getting $29.1 million of economic activity for

---

[1] Present principal landowners are: Ciba-Geigy Corp; Tabernacle Farm Co; W. V. Maness; A. L. Megland; I. T. Cohen; Robert R. Fryar; Vannie Fryar; George A. Denny; Carl D. Hamilton; Northeast Baptist Church

$4.2 million (12.5%). Obviously, this will have a beneficial effect on the area since much of the money will be spent locally. Indirect beneficial effects will accrue as the money circulates.

b. Indirect Effects

Indirect effects are associated with the growth which will occur following the expansion of sewage treatment capacity. They can be more pronounced in the long run than the direct effects. Chapter II presented the projected population and land use patterns assuming that sewage treatment would be universally available. The proposed facilities should not alter these projections. Increases in the population in the North and South Buffalo basins east of Greensboro are anticipated. However, extraordinary growth to the east of the proposed South Buffalo facility is not expected. Therefore, that location will accommodate projected growth but is not expected to extend growth patterns unduly or encourage dispersal into outlying areas. The question of future residential growth will be further addressed in the Land Use section.

Those areas downstream (east) of the North Buffalo plant which are expected to grow (transition areas on Figure II-21) will be served by a dual gravity/force main system with sewage pumped back to the plant. Growth in the Alamance Creek basin portion of the EIS Study Area will be similarly served. Hence, the proposed action serves the projected population growth of the area as delineated in Chapter II. Also, it removes some of the pressure for development north and northwest of Greensboro by opening available vacant land east of the city limits.

If the system were not expanded, the study area's growth would be limited to approximately 45,000 people on the city's facilities by 2000 according to data presented in Chapter III. The projected growth is approximately 90,000 people. Therefore, approximately 45,000 people would have to be dependent upon septic tanks or package plants. Soil conditions severely limit development on septic tanks. Furthermore, package plants are relatively expensive, require extensive planning, and do not dispose of sludge as a part of their operation. In conclusion, growth with reliance upon Greensboro's expanded sewage treatment system is the most attractive alternative for most areas.

If the proposed action allows the area to grow to its projected population, there is going to have to be concomitant growth in the economy of the area to employ the growth increment. Therefore, an indirect effect will be industrial and commercial growth. With the proposed action, this growth can be accommodated within Greensboro on the city's sewage treatment system.

2. Land Use

a. Direct Effects

Land use at the North Buffalo plant will not change since the upgrading will be accomplished within existing boundaries. Land use along South Buffalo Creek from the existing plant to the new site will be affected temporarily during the construction of the outfall. However, no permanent change will result and the period of construction at any one site (farm, residential, etc.) will be short (assuming construction at a rate of 3000 feet per month).

The 400 acres Greensboro will buy for the new South Buffalo plant is currently either forested, in pasture, or in row crops. Row crops represent a very small percent of the total acreage (50 acres at most). The 75-acre plot on which the proposed plant is to be located is pastureland, supporting approximately

20 cattle. This land has very thin soil and is probably not economically suitable for plow agriculture.

The portion of the 400 acres to be purchased as a buffer zone is predominantly timberland and will remain as such to reinforce the buffer. Hence, very little land of high economic value will be lost. With respect to future agricultural productivity, the entire 400 acres has limited potential.

Within 3000 feet of the proposed South Buffalo site there are approximately 30 residential units, 1 church, and 1 grocery. None of these land uses will change in the proposed action.

As a consequence of the proposed action, the existing South Buffalo plant will cease operation. This land will remain as city property, perhaps to be utilized as a recreational facility. In any event, use of that land as "industrial" (the classification for sewage treatment plants) will cease. As a direct result of that action, land values in that neighborhood may increase since it will tend to be a more pleasant area in which to live.

b. Indirect Effects

Indirect impacts on land use consider (1) the study area's ultimate development potential, (2) potential density intensification, (3) changes in land use planning and policies, and (4) changes in land ownership patterns.

Anticipated growth patterns in the year 2000 were presented in Chapter II. These growth areas are not expected to be altered with the proposed action. However, the proposed action does provide a more positive prospect of development occurring east of the present city limits. The new treatment facility will easily provide the South Buffalo (east) subbasin with sewer service. Lift stations and outfall lines provided in the proposed action will also service North Buffalo (east) and Alamance. Urban densities may be expected in North Buffalo (east), South Buffalo (east), and Alamance in the year 2000 as presented in Chapter II. The action will relieve some of the pressure for development in the north and northwest.

A possibility for a "leapfrogging" pattern of development does exist in eastern Guilford County with the proposed placement of the South Buffalo plant. Leapfrogging means that development will occur several miles from Greensboro with undeveloped land in between. However, it would be very difficult to prove that this is going to happen because it will depend largely upon decisions made in the private sector by developers and financial institutions, as well as local county and city zoning decisions.

"Leapfrogging" is not expected to happen on an appreciable scale for three major reasons. First, there is ample land for residential, commercial, and industrial development near Greensboro in the transition zones. Since the supply is available, the demand should not push the cost of land to a level where people will have to seek cheaper rural land for their housing needs. This negates a financial incentive for leapfrogging. Second, a further financial incentive is the higher cost of living far from Greensboro in terms of transportation and utility connections. Finally, Guilford County has the power to limit this possibility through its highway programs and through zoning.

The proposed action will change land ownership patterns in the study area, particularly east of the city limits. Residential, commercial, and industrial uses will replace some of the agricultural land. Nonresidential land use will develop around the new plant with adequate zoning. Land values in the long run will increase east of Greensboro.

3. Community Services and Facilities

a. Direct Effects

Direct effects of the proposed action are related to the population growth which will result from construction and operation as well as the location of a particular component near a public facility. In the first case, the increment of growth caused by construction and operation itself is so small that no additional capacity will be required. As far as the second potential problem is concerned, no facilities are near the new South Buffalo plant. Hence, there will be no adverse effects directly associated with the proposed action.

b. Indirect Effects

As a consequence of growth, Greensboro and Guilford County are going to have to expand certain services and facilities. These required expansions can be thought of as adverse impacts in a strict sense. However, by identifying potential needs now, planning measures by appropriate officials will mitigate the effect.

Assuming the current city ratio of employees to population will continue to the year 2000, and applying this ratio to growth now projected throughout the Study Area, 226 additional police officers and 163 additional firefighters will be needed to serve anticipated population growth. Also, six to nine additional fire stations will be needed.[1]

The educational system will have to expand. Although in recent years the school age population has continued to decline, approximately 15 to 18 additional elementary schools, two or three junior high schools, and one senior high school will be needed by 2000 (CH-399).

---

[1] Estimates based upon criteria suggested by CH-399.

Within the county, branch libraries are opened as need arises. Service areas can be determined, and, if additional library services are needed, branch stations can be opened in shopping centers or other convenient locations.

Health services in Greensboro and Guilford County now appear sufficient, especially with the imminent opening of Humana Hospital. As need arises, new facilities will certainly be provided.

Additional neighborhood and community parks and recreation facilities will be needed to serve the population growth. The city and county could incorporate these facilities into plans for new subdivisions and residential areas.

The water supply for the City of Greensboro (Lake Higgins, Lake Brandt, Lake Townsend) has an estimated safe yield of 46 MGD. Current water use averages 22.5 MGD with an average summer daily use of 27 MGD. The increased water demand from the additional population and industrial growth over the next twenty years will increase this present water use to near the safe yield capacity. For this reason, construction plans for a new reservoir site (Randleman Reservoir on Deep River) with an expected yield of 33 MGD have begun. When completed, this additional reservoir will insure an adequate but still limited water supply for both the cities of Greensboro and High Point. The proposed action essentially commits the city to locating and implementing a new water supply by the end of the design period by accommodating the projected growth. Beyond the year 2000, Greensboro will soon require even more water than that provided by Randleman Reservoir.

4. Taxes and Budgeting

a. Direct Effects

The City of Greensboro is prepared to pay for the proposed action. In the most recent Annual Budget (GR-334), $5.0 million (12.5% of total improvements) had been allocated for sewer improvements through 1980. Of this amount, $1.8 million will come from existing bonds, $1.2 million from proposed bonds, and $2.0 million from revenue sharing. Eighty-seven and one-half percent of the total cost of improvements will come from federal and state funds.

The above bonds will be paid for through user charges and installation assessments. User charges are already scheduled to increase slightly in the near future to produce more revenue. Also, new customers in peripheral areas will be added soon. With Greensboro's favorable bond rating (AA by Moody), the interest should be fairly low. Also, Greensboro's existing debt is relatively low (the total debt service is only 2.5% of assessed valuation). It appears that Greensboro can afford to incur a sewer debt at this time.

Facilities described in the proposed action will provide sufficient wastewater treatment at a cost of approximately $.41/1000 gallons. To upgrade the existing facilities and maintain their capacity with expanded treatment provided through septic tanks constitutes a type of No Action. This alternative would provide treatment at a cost of approximately $.47/1000 gallons owing to the reduced economies of scale.

Other taxes and budgets in Greensboro and Guilford County should not be directly affected by the proposed action.

b. Indirect Effects

Population growth means the growth in services and the cost of government. Obviously, local government wants revenues to increase at least proportionately. If this is the case, disproportionate increases in taxes and budget problems should not occur. As long as local government plans for this situation, there will be no strain on the fiscal condition of the area.

If appropriate planning measures are not taken to insure against leapfrogging and low density sprawl, there may eventually be increases in the cost of public services. For instance, sprawl is very expensive when road and utility costs are considered (RE-118). Increased costs are experienced both in the construction and maintenance of these public facilities. These costs would have to be covered by increased revenues, probably in the form of higher taxes.

5. Archaeological, Cultural, Historical, and Recreational Resources

a. Direct Effects

The upgrading of the North Buffalo plant will not adversely affect any of these resources since no expansion will be required. The closing of the existing South Buffalo plant will be a positive action for the area immediately surrounding it. It may even represent an addition to the recreational resource inventory of Greensboro since the city owns the land. As an area susceptible to flooding, a park is not out of reason for that acreage, and it could be integrated into a recreational corridor that would include the existing playground several thousand feet upstream.

The outfall from the existing South Buffalo plant to the proposed site does not pass through designated recreational areas except the creek itself, and children often play along creeks. However, the construction will proceed rapidly (3,000 feet per month) and, in the long run, the creek area will still be available. Sewer emplacement should not affect the character of the creek since it is almost completely channelized now.

The new South Buffalo site has a house and several small buildings which may be displaced.[1] None of these are on the Guilford County inventory of historic places. Prior to authorization of Step II of the 201 grant process, an archaeological survey will be performed to ensure that any potential archaeological resources are protected or committed. South Buffalo Creek has been channelized nearly to the proposed site so that the probability of sites is lower than it would be in an undisturbed state. Also, 40-50 acres at the potential plant site have been cleared for many years so that any sites may have already been destroyed if they ever existed. Within 3000 feet of the proposed plant perimeter, there are no known historical or archaeological resources.

b. Indirect Effects

Both Greensboro and Guilford County will eventually have to expand recreational facilities to meet future demand. Based upon projected population growth and standard planning guidelines (CH-399), approximately 2000 to 2500 acres of parklands of all types will be needed. However, adequate planning will alleviate any overcrowding of existing facilities which may occur as the EIS Study Area grows, and this planning is facilitated by the sewerage system.

---

[1] The North Carolina Department of Cultural Resources will examine these structures for historical significance and will recommend the appropriate action.

More and more archaeological resources will be lost as the population expands into peripheral areas if these resources exist. However, as these resources are identified, there will be an opportunity to learn more about the past.

6. Transportation

a. Direct Effects

The only road which should experience perceptable change in traffic characteristics will be Huffine Mill Road which is the major thoroughfare from Greensboro to the proposed South Buffalo site. This is now a two-lane, blacktop road in excellent condition. It is the major route from rural areas of northeast Guilford County to Greensboro. During construction this highway will experience significantly greater traffic with many more trucks. However, most of the truck traffic will not be during the daily commuting periods. After the construction is completed, traffic along Huffine Mill Road will revert to current conditions (assuming no other major changes in traffic generators in that area). No significant changes in truck traffic during operation is expected since sludge disposal will be by incineration on site.

The access road to the new South Buffalo site will have to be enlarged and made into an all-weather surface. It is now a dirt road.

Rail, truck, and air transportation in the EIS Study Area will not be affected directly by the proposed action.

b. Indirect Effects

Population growth which will be accommodated by the proposed action will require an expansion in the ground transportation system of Greensboro. The thoroughfare plan shows that growth in all directions from Greensboro will be accommodated regardless of sewage plant location. The proposed South Buffalo plant will be just beyond the major thoroughfares being suggested by the Greensboro Planning Department. Hence, the proposed site will probably not alter future highway patterns in any discernible manner. However, a major new transportation facility paralleling and north of U.S. I-85 east of Greensboro may be necessary if eastward growth becomes a reality.

Air transportation is to expand in the EIS Study Area under current plans. No further expansion is likely to be attributable to population growth through 2000 in Greensboro alone. Rail transportation is adequate at this time and should not be significantly affected by future growth beyond what is already being planned.

7. Resource Use

a. Direct Effects

Materials (steel, cement, stone, etc.) will be required to construct new facilities. There is no shortage of these resources in the Study Area. Electricity to meet the plant demands will be available as long as Duke Power can meet its total energy commitments; the system will consume less than one percent of the total current electrical demand in the Greensboro area.

b. Indirect Effects

Population and economic growth in the EIS Study Area will require more energy in the future. Duke Power is now relying on coal for 62% of its power with 34% coming from nuclear plants. Therefore, shortages of oil and gas for power production are less severe in the Greensboro area than in other areas.

Regardless, with the energy future of this country in great flux, no one can safely predict the adequacy of future energy supply.

Other physical resources currently being exploited in Guilford County are not going to be depleted as a result of population growth predicted in Chapter II.

VI. UNAVOIDABLE ADVERSE IMPACTS AND MITIGATING MEASURES

A. Natural Environment

1. Air Quality

This section addresses adverse air quality impacts and the measures that may be taken to mitigate them. The only adverse impact estimated to occur will be caused by fugitive dust generated by construction activities at the new South Buffalo sewage treatment plant site, depending upon weather conditions during the construction period. To prevent dust generation, frequent watering may be employed. Dust generation may also be reduced by restricting the speed of hauling trucks traveling over unpaved roads to the site. These measures should reduce dust generation approximately 50 percent.

2. Odor

Municipal wastewater treatment facilities have been odor sources and it is doubtful whether such odors can ever be completely eliminated at all times. A properly operated aeration system should minimize odor problems but even these facilities have characteristic odors. Wastewaters which travel significant distances before reaching the treatment facility often become septic and release obnoxious odors at the plant outfall or well or at the intermittent manholes. Additionally, unit processes throughout the treatment facility which are not supplied with auxiliary aeration, such as primary clarifiers and sludge thickeners, may develop anaerobic zones and produce malodorous hydrogen sulfide (H_2S). Almost all facilities associated with sludge handling and processing will at times be characterized as an odor nuisance, especially in summer conditions.

Various structural as well as non-structural actions can be taken to help minimize or reduce potential odor-associated adverse impacts. The most obvious non-structural action is to locate any new facilities away from communities and to pass local legislation prohibiting encroachment of development on the facility. Purchase of land for use as a buffer zone is helpful in this regard. By minimizing the number of people affected, potential adverse impacts are reduced.

Possible structural mitigative measures include the use of masking agents, covers and gas scrubbers for each of the major odor producing unit processes, and pre-disinfection at various locations along the collection system. However, even with the installation of the most sophisticated odor control facilities, residual inherent odors will persist. Pre-treatment and proper operation and maintenance of both plants will help keep odor levels low.

Current odor control at the North Buffalo Creek plant includes the use of masking agents. While odor complaints are recognized, the number is minimal and this practice appears to have some beneficial effects considering the extent of development surrounding the facility. Other measures which could be considered for odor control include the installation of covers and gas scrubbers on the sludge thickeners as well as scrubbers on both the anaerobic digestion facilities and the sludge vacuum filters. Covers for the thickeners can be constructed with a aluminum siding material and supported with reinforced fiberglass beams. These covers are light-weight and can be easily removed for servicing. The cost for this odor control will increase the total capital cost for improvement at North Buffalo by approximately $200,000 or 5 percent and the total operation and maintenance cost by approximately $40,000 per year.

Consideration of odor control measures for the proposed new facility should include covers and scrubbers for the primary clarifiers and sludge thickeners as well as gas scrubbers for the vacuum filters. Additionally, since the wastewater must travel a relatively long distance before reaching the new facility, pre-chlorination facilities located at the existing South Buffalo Creek plant site should be considered to reduce the odor potential from septic conditions at the outfall. The cost for these facilities would increase the capital cost of the new facilities by approximately $250,000 and the operation and maintenance cost by approximately $80,000 per year.

3. Noise

The major impact of noise will occur during construction phases and the degree of effect will depend heavily upon population density and proximity of human habitation to noise sources. Residences within about five hundred feet of construction activity are expected to be subjected to noise intrusion during daytime hours that will be of sufficient strength to be a source of interference with normal human activity. Such interference will likely be limited to no more than one-month duration for any single residence or receptor during construction of the South Buffalo outfall.

The impact of noise from construction activity and equipment can be mitigated by proper maintenance of operating equipment and installation of noise-attenuating devices. Dozers, backhoes, and cranes are major noise sources, and modern exhaust muffling equipment will significantly reduce levels of radiated noise from these sources. Techniques developed in the mining industry (US-373) provide a means of reducing rock drill noise levels. Reductions of 6-7 dBA are possible with muffler and barrier.

Noise emissions from acoustically untreated diffuser aerators could cause adverse human reaction within 1,000 feet of the plant site. Control measures for reducing levels of noise radiation include enclosure of motors and pumps, enclosure or acoustical lagging of control valves, and acoustical lagging of all above-ground high-pressure piping.

4. Geology

The most significant unavoidable adverse geologic impact involves the new sewage treatment plant site where hard, tough bedrock is overlain by only a thin soil mantle. Considerable blasting may be required in some areas during construction of the plant. This impact will be of short duration, however, and no mitigative measures should be required.

5. Soils

The most important adverse impact on the soils will be the removal of about 40 acres of soil from agricultural productivity. However, the soil at the site is only moderately productive, so this loss is not highly significant. A possible mitigative measure would be to clear an equivalent area of non-productive woodland at another location and place it in a similar agricultural status. On the other hand, the annual changes in agricultural land use in the region probably overshadow the local effects of removing 40 acres from production or trading off the current agricultural use for similar use at another location. The gradual removal of agricultural lands from production via urbanization is an indirect impact best mitigated by proper zoning.

Soil erosion and stream siltation are addressed below under "Water Quality."

6. Water

Streamflow

The gradual increase in stream discharge downstream of the new outfalls and the decrease in stream discharge below the old South Buffalo STP are unavoidable. However, hydraulic impacts associated with this changing flow regimen, as identified in Chapter V, are minor.

The major adverse impacts to streamflow in the Greensboro area will occur from increases in impervious acreage and percentage of storm sewers in watersheds experiencing urbanization. These impacts include in order of decreasing magnitude:

- Higher Flood Flows
- More Flash Flooding
- More Frequent Flooding
- Less Recharge to Ground-Water Aquifers

To minimize the effects of these impacts, a storm water management program is needed to both reduce the amount of impervious area and storm sewers and control the runoff from these areas. A general policy of land management was adopted in January, 1977 by the Guilford County Board of County Commissioners which calls for "slower water runoff" and "retainment of natural vegetation" where feasible in new developments. Although no specific measures to implement these goals are suggested, the policy is a step in the right direction.

The most direct measure to reduce storm runoff is to minimize the percentage of impervious cover within watersheds. One effective measure to accomplish this goal is the adoption of a minimum residential lot size ordinance. As shown in the following table, as lot size increases the corresponding percentage of impervious surface area decreases dramatically.

Lot Size of Residential Area		Impervious Surface Area
Square Feet	Acres	Percent
6,000	.14	80
10,500	.24	40
15,000	.34	25
22,000	.51	19
43,600	1.00	13
78,400	1.80	8

Source: LE-309

However, as the larger lot sizes encourage undesirable urban sprawl (as identified in the Man-Made Environment section) a reasonable lot size to minimize the undesirable effects of both impervious cover and urban growth is recommended. Determination of the most environmentally sound lot size requires more detailed studies of each watershed's drainage characteristics and desired development scenarios than is necessary for the EIS but is an appropriate mitigating measure.

Additional measures to reduce storm runoff include construction of detention ponds downstream of developments to reduce the peak flows further downstream and encourage aquifer recharge or delayed subsurface runoff. Pavements with substantial areas of permeable surface are also becoming an economical solution of controlling surface runoff at the source and building codes should be adopted to encourage its use.

Water Quality

The most likely direct impact on stream water quality that is unavoidable derives from the erosion and increased suspended sediments associated with construction of proposed facilities, especially sewers. The principal adverse effect of this temporary siltation probably pertains more to aesthetic degradation than habitat degradation in the receiving streams, but generally such siltation can be readily avoided (EN-101). The erosion and sedimentation control plan, required by the State of North Carolina for such facilities (NO-139), should provide for effective sediment control through such measures as minimizing construction in and crossing streams by environmentally sound sewer alignment, avoiding steep slopes, removing excess material, continuous backfilling of trenches, diverting runoff away from undisturbed areas, timely revegetating disturbed areas with grasses and legumes for stabilization and sediment filtering, and using detention or retention basins in critical areas.

During very rare non-standard operating conditions at the treatment plants and pumping stations, a very small probability exists of raw or poorly chlorinated sewage bypassing the system. The chance of this bypassing degrading water quality or creating a public health hazard can be virtually eliminated by having a back-up system with additional pump(s) and an automatically operated diesel-powered generator and a large detention structure for interim storage of sewage beyond the wet well. Such measures can be costly (on the order of several hundred ttousand dollars) but may be appropriate for protection of waters used for water supply and contact recreation.

Another direct adverse impact which probably cannot be avoided to some extent will be the inadvertent chlorination of some hydrocarbon derivatives in the wastewaters to form potentially dangerous compounds. The only mitigating factor that would avoid this impact completely is disinfection using ozonation rather than chlorination. However, the concentrations of these compounds in receiving waters are likely to be very small, and a periodic effluent monitoring program for trace organics would permit detection of any potential problems and subsequent implementation of ameliorative measures.

By far the most significant unavoidable adverse impacts to water quality are those associated with increased amounts of urban runoff of poor quality. Such runoff will probably control the future quality of water and aquatic habitat in the upper reaches of streams in the study area and may prevent improvements in point source effluent quality from significantly increasing stream quality in much of the area. While not avoidable, the effects of urban runoff can be reduced. Such mitigation must recognize the two physical processes controlling urban non-point pollutant sources. First is the accumulation of pollutants on the land surfaces between storm runoff events. The second is pollutant removal and transport to the receiving stream.

The accumulation of pollutants is probably impossible to eliminate in an urban setting; however, methods which help to reduce the rate of accumulation do exist. Street sweeping will remove a large quantity of debris that accumulates in the streets. Unfortunately, several studies which sampled street litter have shown that the major portion of many street surface contaminants are contained in dust and fine dirt. Street sweeping will not effectively remove the "dust and dirt" portion of street debris. Public awareness and support of litter control measures also can reduce pollutant accumulation. Even increases in air quality have been shown to improve the quality of rainfall and reduce the quantity and noxious quality of particulate matter settling on land surfaces.

Land use planning in developing areas can reduce the quantity of pollutants transported to the receiving lake or stream. Conventional urban drainage systems are designed for the rapid removal of stormwater from the urban areas. Flow velocities within storm sewers are designed to scour sediment and debris from the system, with ultimate discharge to the receiving stream. Impervious areas (i.e., streets and parking lots) not only increase the quantity of runoff but also increase overland flow velocities. The sediment transport capacity of water is directly and geometrically proportional to flow velocities; in other words, the ability of water to carry debris increases greatly with small increases in velocity. Consequently, the use of drainage systems designed to reduce flow velocities in secondary or tertiary drainage systems will tend to reduce non-point source loadings to area streams. Grass-lined roadside swales and stormwater detention ponds will reduce velocities and encourage sedimentation. Grass buffer zones around impervious areas, where possible, will provide a certain degree of filtration of stormwater as well as reduce flow velocity. Channels and floodplains of area streams that are left undisturbed to the extent possible will provide further buffering and reduction of flow velocities as compared to channelization. However, in the larger trunk channels, the flooding potential may be an overriding concern and require more effective hydraulic conveyance.

A less obvious unavoidable impact is an increased, continued reliance on septic tanks for wastewater treatment for the growing population on the periphery of the 201 area. The soils of the entire Greensboro area are generally unsuitable for intensive septic tank usage, and the water quality degradation due to malfunctioning septic tanks can be expected to continue. Non-structural measures that should be implemented to reduce this water quality and public health hazard include economic and legal incentives for properly maintaining septic tanks by owners and also substantial increase in the stringency of percolation tests (e.g., the number or percentage of successful tests performed per site) before a septic tank may be approved. The wastewater service agreement between the city and Guilford County may be the most appropriate vehicle to implement these non-structural measures.

Ground Water

There are no unavoidable adverse impacts to the groundwater system. The primary possible impact of the proposed project is the potential local ground-water quality hazard posed by the new sewage treatment and transmission facilities. The best mitigative measure for this potential problem is preventive and consists of assuring that all facilities are leak-proof by proper engineering design and construction. If detailed site studies for the new plant indicate further that ground water will be affected, the best mitigative measure may then be to install two or more water quality monitor wells down-gradient from the plant site (i.e., between the site and South Buffalo Creek). Leak-resistent methods of construction for the raw sewage pipelines will assure that no contamination of the small aquifer associated with South Bufflo.

7. Land/Water Interface

Some increases in the flood flows of area creeks due to urbanization are unavoidable in the Greensboro area. However, appropriate mitigating measures can be taken to both minimize the increases and protect property when increases are unavoidable. Environmentally sound measures (as discussed in the Water Section) to minimize increases in flood levels include: ordinances requiring a minimum lot size; construction of detention ponds; utilizing permeable surfaced roadways and parking areas; and minimizing the construction of storm sewers and channelized stream segments.

However, even with the above measures, some increases in impervious cover and corresponding increases in flood levels will still occur. For this reason, proper management of both existing and potential flood-prone areas is essential. Enforcement of programs similar to the Guilford County Board of Commissioners' policies to prohibit development in "floodways, floodplains, and areas adjacent to public reservoirs" is necessary to minimize flood damages to both the natural and man-made environment.

Although presently there is little development within the floodplains in the Greensboro area, with increased urbanization more developments will soon be within flood damaging areas. Measures to protect these developments should therefore be undertaken as soon as possible to prevent flood damages. One direct measure is the construction of small earth levees to prevent water intrusion. As long as these levees do not substantially reduce the natural cross-sectional area of the stream, their effects are generally minimal. Recent measures to minimize flood damages include "flood proofing" whereby structures in flood-prone areas are built to minimize flood damages. An example of this type of mitigating measure is the construction of a multi-level complex where the ground level is a parking garage.

As increases in flood elevations are much more sensitive to changes in impervious cover below about 10% (Chapter V.B.1.g.), the adoption of policies encouraging development in presently urban watersheds (e.g., North and South Buffalo Creeks) rather than in watersheds with little existing development (e.g., Little Alamance and Brush Creeks) is an appropriate mitigating measure. The location of the new South Buffalo plant should not be a disincentive for this type of development.

8. Biology

The only short-term adverse impact that will occur as a result of implementing the proposed action will be disturbance of terrestrial flora and fauna in areas of construction. This disturbance will be temporary and can be mitigated by careful choice of access roads to construction sites, muffling of engine noise, and use of the narrowest practical right-of-way along the pipeline route. Short-term adverse impacts on aquatic biota will occur as a result of erosion and subsequent stream siltation from vegetation loss at construction sites. Because both streams are currently in very poor condition, these impacts will be slight. They can be mitigated by employing construction methodologies recommended in the state's rules and regulations governing erosion and sedimentation control (NO-139) and quick revegetation of denuded areas.

The discharge of treated sewage effluent into a stream is usually considered to be a long-term adverse impact associated with this type of project. In the case of this proposed action, however, the discharge of a higher quality effluent into North and South Buffalo Creeks will have a beneficial impact. Both streams have been badly degraded by man's use through time such that no adverse impact from the new discharges is anticipated. However, lower flows in the 26,000-foot segment of South Buffalo Creek upstream from the new sewage treatment plant will favor the growth and reproduction of vectors[1] such as mosquitoes and flies. Moist banks and backwater areas in this segment will provide excellent growth conditions for these species. Available mitigating measures for this adverse impact will be determined by federal and state regulations which govern the use of suitable vector control agents as well as local public health regulations. This mitigating measure has the potential for generating its own adverse impacts if not carefully selected and applied. Indiscriminate use of vector control agents could further degrade general habitat quality in and along the stream and introduce highly toxic substances into the food chain.

The following chart delineates the unavoidable biological impacts associated with the proposed action and available mitigating measures:

Unavoidable Biological Impacts	Potential Mitigative Measures
Construction Disturbance	
1. Noise	Muffle engines of heavy equipment
2. Exposed Soil and Erosion	Revegetate exposed areas quickly
3. Siltation	Revegetate exposed areas quickly and employ other methods as outlined in the state's Rules for Erosion and Sediment Control such as diversion ditches and catch basins
4. Natural vegetation loss	Use as narrow pipeline easements and as small construction sites as possible
Operational Disturbance	
1. Noise	Install noise-deadening material around noise sources where possible
2. Odors	Operate treatment facility efficiently to avoid upset conditions
3. Effluent discharges: High BOD, TSS, and Low DO	Operate treatment facility efficiently to stay within BOD_5 and TSS standards. Use temporary holding ponds to store untreated sewage during upset or overload conditions to avoid bypassing into creeks.

---

[1] disease-carrying or transmitting insects

B. Man-Made Environment

Adverse effects related to the conflicting land uses near the proposed South Buffalo site will be minimized by the open space buffer which will be provided. This is an especially good buffer since it is heavily forested.

The North Carolina Department of Archives and History will recommend the appropriate action should historic structures or archaeological resources be endangered by the proposed action.

Huffine Mill Road may become somewhat congested during periods of intense construction activity. This problem can be relieved by scheduling activity at times of low traffic flow.

Population growth which will be accommodated in the EIS Study Area can be thought of as an unavoidable consequence of the proposed action. Whether it is adverse or not is a question for which the answer requires a value judgement. A recognition of the growth potential is the mitigating measure. With a reliable projection, decision-makers in the private and public sectors can formulate plans to correct possible deficiencies before they occur rather than wait for them to become obvious in a socially undesirable form.

The possibility of leapfrogging development in eastern Guilford County exists. While the agencies feel that this will not be a major trend, Guilford County and Greensboro can induce growth near the city edge, guarding against leapfrogging, through local development controls such as zoning, subdivision regulation, sewer tap permits, and construction permits.

Nearly all community services and facilities will have to be expanded or enlarged because of the population growth which can be expected. The appropriate mitigating measure is farsighted planning, not only by city and county government, but by the administrators of the various services and facilities such as public safety, fire protection, health care, education, and so on.

The future transportation plan (Chapter II) will accommodate the future traffic. However, transportation planners will need to monitor traffic flow carefully to insure that overloading does not occur. This is especially true east of Greensboro.

VII. COORDINATION WITH OTHERS

During the course of developing the EIS, much information and assistance were provided by various federal, state and local agencies and interested members of the community. Those governmental offices that were contacted and the nature of their contribution to the preparation of this EIS are listed on the pages that follow.

The following offices and agencies participated directly in the preparation of this Draft EIS.

EIS Preparation Branch, Region IV
U.S. Environmental Protection Agency
Atlanta, Georgia

Environmental Coordinator
North Carolina Department of Natural
and Economic Resources
Raleigh, North Carolina

Division of Environmental Management
North Carolina Department of Natural
and Economic Resources
Raleigh, North Carolina

The City of Greensboro
Public Works Department
Publications Department
Greensboro, North Carolina

GREENSBORO EIS CONTACTS

CONTACT	PURPOSE
U.S. Environmental Protection Agency, Region IV Air Programs Branch Atlanta, Georgia	Discuss status of current state implementation plan.
U.S. Geological Survey Raleigh, N.C.	Obtained various information on surface water records and open file reports.
Environmental Protection Agency Region IV Water Quality Division Atlanta, Georgia	Obtained STORET data for Guilford County, N.C.
U.S. Department of Agriculture Soil Conservation Service Guilford County Field Office Greensboro, N.C.	Obtain soil maps and descriptions for Guilford County, North Carolina.
U.S. Department of Agriculture Soil Conservation Service Alamance County Field Office Burlington, N.C.	Obtain county soil report for Alamance Co., N.C.
U.S. Department of Agriculture Soil Conservation Service Forsyth County Field Office Winston-Salem, N.C.	Obtain county soil report for Alamance Co., N.C.
U.S. Fish & Wildlife Service Federal Building Raleigh, N.C.	Endangered species in North Carolina.
NCDNER DEM Air Quality Section Greensboro Department of Public Works Greensboro, North Carolina	Obtain air quality data for study area. Obtain air pollution data on sludge incinerator at North Buffalo STP.

CONTACT	PURPOSE
Ground Water Section Winston-Salem Field Office N.C. Dept. of Natural and Economic Resources Winston-Salem, N.C.	Ground water hydrology and resource availability.
Dept. of Cultural Resources State of North Carolina Raleigh, N.C.	
State of North Carolina Dept. of Natural and Economic Resources Ground Water Section North Piedmont Field Office Winston-Salem, N.C.	Obtain maps for ground water parameters in Guilford County, review draft copy of county ground water reconnaissance report.
State of North Carolina Dept. of Natural and Economic Resources Mineral Resources Section Raleigh, N.C.	Obtain geologic map of Guilford County, N.C.
N.C. Wildlife Resources Commission Albemarle Building Raleigh, N.C.	Plants and animals of study area; game animal and sport fish populations.
N.C. State Museum of Natural History Raleigh, N.C.	Threatened/endangered plants and animals in Guilford Co.
N.C. Dept. of Natural and Ecological Resources Raleigh, N.C.	Water quality data.
Guilford County Public Health Dept. Greensboro, N.C.	Request records of odor complaints.
Geology Department Guilford College Greensboro, N.C.	Coordination of the current stream and lake monitoring program.
Guilford County Department of Public Health Greensboro, N.C.	Septic tank permit requirements and the extent of failures and malfunctions.

CONTACT	PURPOSE
Cone Mills Corporation Greensboro, N.C.	Requested information on the water quality of their water supply (Lake Buffalo).
Greensboro Water Treatment Plant Greensboro, N.C.	Obtained information on the water quality of Lake Brandt and Lake Townsend.
University of Greensboro Greensboro, N.C.	Local floral and faunal research.
North Carolina State University Raleigh, N.C.	Rare/endangered species in the Greensboro area.
Planning Department City of Greensboro Greensboro, N.C.	Data concerning population, land use, economics, transportation, community services and facilities, growth, scenarios, sensitive areas.
Planning Department Guilford County Greensboro, N.C.	Land use ordinances, county zoning maps, transportation maps.
Chamber of Commerce Greensboro, N.C.	Greensboro Atlas, economic data, population data.
Public Library Greensboro, N.C.	Establish reading area for local citizens.
Parks and Recreation Dept. Greensboro, N.C.	Recreation inventory.
Piedmont Triad C.O.G. Greensboro, N.C.	Data on land use, land use trends.
Tax Collector Greensboro, N.C.	Tax data.
Tax Assessor Guilford County Greensboro, N.C.	Tax data.
Public Works Department Greensboro, N.C.	Sewer rates.
City Manager Greensboro, N.C.	City budget.

CONTACT	PURPOSE
School Superintendent Guilford County Greensboro, N.C.	Data concerning educational system.
Employment Security Commission Raleigh, N.C.	Guilford County employment data.
Office of the Mayor Greensboro, N.C.	Greater Greensboro planning activities.
Guilford County Planning Commission Greensboro, N.C	Land use, population forecasts, master plans.
Office of Congressman Pryor Greensboro, N.C.	Resolutions of design flow.

GREENSBORO EIS ADVISORY COMMITTEE

An advisory and review committee was organized to provide a forum for obtaining citizens input during development of the EIS. This group, called the Greensboro EIS Advisory Committee (GAC), was comprised of citizens representing a variety of parties of interest in the selection of Greensboro's wastewater management system. During preparation of the EIS, the GAC:

1. Became informed through provided materials and other means on the EIS and PL 92-500, Section 201 processes and their purposes;
2. Reviewed and provided comment on an advance version of the EIS chapter--Chapter II, Existing Environment--to ensure that major local areas of interest had been covered;
3. Provided judgements on the relative importance of selected environmental categories that were used as inputs to the alternatives environmental evaluation system;
4. Reviewed the selected design flow and provided comments;
5. Recommended additional wastewater treatment plant sites to be considered in the alternatives evaluation process;
6. Provided recommendations on preferred alternatives; and
7. Critiqued the proposed action.

Solicitation for representatives for GAC was first made at the November 10, 1977 public meeting at the municipal auditorium; 986 people registered. After organizing the committee, a series of meetings were held to obtain inputs at several decision periods in the EIS process and to keep representatives informed on the EIS status. Meeting dates and major topics covered in each meeting are listed below:

December 21, 1977 - Orientation and instruction on legislation, authorizations, EIS structure and purpose.

January 17, 1977 - Detailed discussion of Chapter II and each of twenty-two environmental categories (see Table III-4) and ranking by GAC of the importance of each category in the Greensboro environment (see Table III-5).

March 16, 1977 - Discussion of results of environmental rankings by GAC; description of new design flow and the basis for development of 124 new alternatives; recommendations from GAC on additional alternatives.

May 2, 1977 - Discussion of screening process used to eliminate all but eleven alternatives that were selected for the next level of environmental and economic analysis; inputs from GAC on preferred alternatives after review of prepared material and discussion period.

May 19, 1977 - Discussion of six alternatives that were selected from eleven; recommendations were made for investigation of a new site as a potential location for the South Buffalo plant

July 12, 1977 - Discussion of detailed environmental, economic, engineering, legal, and social aspects of seven alternatives including No Action; discussion and description of the proposed action.

Following is a listing of representatives and organizations serving on the GAC:

Mr. Ray Shaw Mr. Charles Mortimore	City of Greensboro
Mr. Gaston Faison Mr. Brent A. Hall	County Commissioners
Mr. Tom Routh Mr. Thomas E. Hubert	Chamber of Commerce
Mr. Carl Loop Mr. Lindsey Cox	PTCOG
Mr. Fred Clapp Mr. Richard Rough	Board of Realtors
Mr. David Dansby Mr. Herman Fox	Greensboro Citizens Association
Dr. Burley Webb Mr. Gerard Gray	North Carolina A & T University
Mr. John Jezorek Dr. Ernest Lumsden	Environmental Action Coalition
Ms. Jean Lumsden Ms. Ellen Olson	League of Women Voters
Mr. Francis Steltzer Mr. Bob Cole	Rural/Suburban Community
Ms. Pat Walker	The Sierra Club
Ms. Betty Cone Dr. Paul Lutz	Guilford County Advisory Board for Environmental Quality
Mr. R. L. Thomas Mr. William Ashworth	Concerned Citizens of McLeansville

Mr. S. T. Hoffman Ms. Judy Huckabee	McLeansville Community Council
Mr. E. R. Lashley	Piedmont Council of Engineering and Technical Societies
Mr. J. B. Erwin Mr. B. J. Battle	NAACP
Ms. Ann Lineweaver Mr. Herbert Reese	GATEWAYS
Mr. Jim Jobe Mr. Bill Anderson	McLeansville Merchants Association
Mr. Tom Veal	Greensboro Jaycees
Mr. Tom Duckwall Mr. R. H. Souther	Audubon Society
Mr. W. S. Griswold	Homebuilders Association

BIBLIOGRAPHY

Chapter II

BA-157 Barry, Robert E. and David P. Hoffman, "Computer Model for Thermal Pollution", ASCE, J. Power Div. 98(P01), 117-32 (1972).

BA-492 Barick, Frank B., *Management of the White-Tailed Deer in North Carolina*, Raleigh, N.C., North Carolina Wildlife Resources Commission, Game Division, March 1953.

BR-355 Braun, E. Lucy, *Deciduous Forests of Eastern North America*, Philadelphia, Blakiston Co., 1950.

BR-358 Brown, Ken, Private Communication, City of Greensboro, Lake Townsend Water Treatment Plant, December 8, 1976.

BR-359 Braughler, Owen, Private Communication, Guilford County Public Health Department, Greensboro, North Carolina, November 6, 1976.

CA-380 Carnes, William C., James R. Davis, and Buford L. Tatum, *Survey and Classification of the Deep-Haw Rivers and Tributaries, North Carolina*, Final Report, Raleigh, North, North Carolina Wildlife Resources Commission, 1964.

CH-168 Charles, M.E., "Transport of Solids by Pipeline", Paper A3, *Proceedings, First International Conference on Hydraulic Transport of Solids in Pipes*, September, 1970, Cranfield, Bedford, England, British Hydromechanics Research Association, 1971.

CL-093 Clay, James W., Douglas M. Orr, Jr., and Alfred W. Stuart, North Carolina Atlas, Portrait of a Changing Southern State, Chapel Hill, North Carolina, University of North Carolina Press, 1975.

CO-052 Cottrell, William B., *Compilation of United States Nuclear Standards*, 5th ed., ORNL-NSIC-57, Oak Ridge, Tenn., Oak Ridge National Lab., 1968.

CO-391 Conant, Roger, *A Field Guide to Reptiles and Amphibians of the United States and Canada East of the 100th Meridian*, Illustrated by Isabelle Hunt Conant., Boston, Houshton Mifflin, 1958.

CO-582 Cooper, K.E., S.S. Roberts, and J.B. Funderburg, *Endangered Plants and Animals of North Carolina*, Raleigh, N.C., Museum of Natural History, 1977.

DA-227 Dawley, Charlotte, *The Birds of Guilford County*, North Carolina, Reprinted from *The Chat 18*(2), June 1954.

DI-128 Dinga, Carl F., et al., *Population and Urban Growth, Projected Water Requirements and the Potential Availability of Ground and Surface Water Resources in Guilford County*, North Carolina, University of North Carolina at Greensboro, February 1975.

EN-485 Engineering-Science, Inc., *North Carolina Air Quality Maintenance Area Analysis*, Final Report, Volume I, EPA 904/9-76-005a, EPA Contract No. 68-02-1380, Task 7, McLean, Virginia, April 1976.

ER-038 Eric Hill Associates, Subcontract interim report to Radian Corporation, May 1977.

FE-187 Federal Water Pollution Controll Admin., Middle Atlantic Region, *Water Quality Survey, Haw River Sub-Basin, Summer 1969*, Data Report No. 3, 1969.

FI-137 Fish, Frederic F., *A Catalog of the Inland Fishing Waters in North Carolina*, Raleigh N.C., North Carolina Wildlife Resources Comm., Division Inland Fisheries, 1968.

FL-063 Flora, Snowden D., *Hailstorms of the United States*, Norman, University of Oklahoma Press, 1956.

FL-077 Floyd, Edwin O. and Richard R. Peace, *An Appraisal of the Ground-Water Resources of the Upper Cape Fear River Basin North Carolina*, Ground Water Bullentin Number 20, U.S.G.S. and the North Carolina Office of Water and Air Resources, May 1974.

FU-072 Funderburg, J.B., Jr., *The Populations, Habitat, Relations and Ecological Changes in the Winter Birds of the Raleigh, North Carolina Region 1880-1959*, Ph.D. Dissertation, North Carolina State University, 1959.

GR-263 Greensboro, City of, North Carolina, Community Council, *Report of Committee on the Study of Health Services*, 1965.

GR-272 Greensboro, City of, North Carolina, Chamber of Commerce, Council on Research, *Greensboro Research Report on... General Characteristics of the Population: 1970 Greensboro--By Census Tract*, Greensboro, North Carolina.

GR-279 Greensboro, City of, North Carolina, Department of Planning and Community Development, "Greensboro Urban Area Transportation Stuyd, Annual Report 1974-75", Greensboro Daily News 1975 (Dec. 7).

GR-291 Greensboro, City of, North Carolina, Planning Dept., Unpublished data RE: population.

GR-292 Greensboro, City of, North Carolina, Planning Dept., Unpublished data RE: retail openings and closings.

GR-293 Greensboro, City of, North Carolina, Planning Dep., Unpublished data RE: new manufacturing locations.

GR-294 Greensboro, City of, North Carolina, Chamber of Commerce, Private communication with Tom Routh, Dec. 8, 1976 and Dec. 9, 1976.

GR-295 Greensboro, City of, North Carolina, Planning Dept., Map of environmentally sensitive area, 1976.

GR-296 Greensboro, City of, North Carolina, Planning Dept., Unpublished data RE: employment projections for non-farm industries.

GR-297 Greensboro, City of, North Carolina, Budget and Research Dept., Private communication with Him Sykes, Dec. 8, 1976.

GU-105 Guilford, County of, North Carolina, Storet water quality data for Greensboro, N.C. obtained from EPA Region IV, Nov., 1976.

GU-106 Guilford, County of, North Carolina, Finance Dept., Private communication with Al Wellman, Dec. 8, 1976 and Dec. 13, 1976.

HA-527 Hazen and Swayer, Greensboro-Guilford 201 Facilities Plan, references, 2 vols., Raleigh, N.C., various dates.

HA-544 Hazen and Sawyer, Greensboro-Guilford County Regional Wastewater Facilities Plan, Environmental Assessment Statement, Raleigh, N.C., 1974.

HE-214 Hendrickson, H.T., "Biological survey of South Buffalo Creek, Horsepen Creek and North Buffalo Wastewater Treatment Plant Site", Appendix D, in Greensboro-Guilford County Regional Wastewater Facilities Plan, Environmental Assessment Statement, City of Greensboro, North Carolina, Raleigh, N.C., Hazen and Sawyer Engineers, undated.

HE-216 Hendrickson, H.T., Greensboro-Guilford County Regional Wastewater Facilities Plan, Environmental Assessment Statement, City of Greensboro, North Carolina, addendum #16, Raleigh, N.C., Hazen and Sawyer Engineers, Jan. 1976.

HE-222 Hendrickson, Herbert T., Private Communication, University of North Carolina at Greensboro, November 1976.

HO-318 Howard, Joe, Private communication, Duke Power, Dec. 2, 1976.

KU-117 Kuchler, A.W., "The Potential Natural Vegetation of the Conterminous United States", in The National Atlas of the United States of America, U.S. Geological Survey, Washington, D.C., 1970.

LE-266 LeGrand, H.E., Ground Water of the Piedmont and Blue Ridge Provinces in the Southeastern States, Geological Survey Circular 538, U.S.G.S., 1967.

LI-168 Ligon, David, Private Communication, North Carolina Dept. of Natural and Economica Resources, Winston-Salem, N.C., November 8, 1976.

MC-249 McDaniel, Ron and Ben McKenzie, comps., Active Mining Operations in North Carolina, North Carolina Dept. of Natural and Economic Resources, January 1976,

MU-130 Mundorff, M.J., Geology and Ground Water in the Greensboro Area, North Carolina, Bullentin Number 55, Raleigh, N.C., North Carolina Dept. of Conservation and Developmnet, Division of Mineral Resources, 1948.

NA-166 National Oceanic and Atmospheric Administration, Climates of the States, 2 Volumes. Volume 1: Eastern States, Puerto Rico, U.S. Virgin Islands; Volume 2: Western States, Alaska, Hawaii, Port Washington, N.Y., Water Information Center, Inc., 1974.

NA-274 National Climatic Center, Wind Distribution by Pasquill Stability Classes, Star Program for Selected U.S. Cities, Asheville, N.C. (1970-1975).

NA-337 Narkunia, James, Private Communication, North Carolina Department of Natural and Economic Resources, Division of Environmental Management, Ground Water Section, Oct. 19, 1976.

NO-111 North Carolina, State of, Department of Natural and Economic Resources, Division of Environmental Management, Water Quality Management Plan, Cape Fear River Basin, Sub-Basin 02, Raleigh, N.C., Environmental Management Commission, October 1974.

NO-112 North Carolina, State of, Department of Natural and Economic Resources, Office of Water and Air Resources, Rules and Regulations Governing the Control of Air Pollution, Raleigh, N.C., Board of Water and Air Resources, 1972.

NO-116 North Carolina, State of, Wildlife Resources Commission, Division of Game, Management of the Bobwhite Quail in North Carolina, revised edition, Raleigh, N.C., June 1972.

NO-119 North Carolina, State of, Employment Security Commission, Private Communication with Floyd Outland, December 7, 1976,

NO-120 North Carolina, State of, Department of Natural and Economic Resources, Extinct, Endangered, and Threatened Vascular Plants of Primary Concern, Circa 1975.

OL-046 Oliver, J., et al., Seismology, Responsibilities and Requirements of a Growing Science, pt. 1., Washington, D.C., National Academy of Science, 1969.

OO-004 Oosting, H.J., "An Ecological Analysis of the Plant Communities of Piedmont, North Carolina, American National 38, 1-126 (1942).

RA-340 Rains, Bernard A., Mario J. DePrimo, and I.L. Groseclose, *Odors Emitted from Raw and Digested Sewage Sludge*, EPA 670/2-73-098, Kansas City, MO, EPA, Region VII, December 1973.

RA-R-406 Radian Corporation, Technical Reference Document Prepared for Greensboro, North Carolina Wastewater Treatment Facilities, EIS, June 1977.

RO-285 Ross, Glenn and Steve Lund, *Assessment of North Carolina Ambient Air Quality Data for 1975*, North Carolina Dept. of Natural and Economic Resources, Division of Environmental Management, Air Quality Section, May 1976.

SI-138 Simmons, Clyde E., *Sediment Characteristics of Streams in the Eastern Piedmont and Western Coastal Plain Regions of North Carolina*, Raleigh, North, U.S.G.S., 1975.

US-305 U.S. Fish and Wildlife Service, "Threatened of Endangered Fauna or Flora, Review of Status of Vascular Plants and Determination of 'Critical Habitat'", *Fed. Reg. 40* (127), Pt.V (1975).

US-528 U.S. Department of Commerce, Bureau of the Census, *Statistical Profile, Greensboro and Greensboro/Winston-Salem,/High Point SMSA*, Greensboro, N.C., Greensboro Chamber of Commerce, Countil on Research.

US-557 U.S. Department of Commerce, Bureau of the Census, *Census of Population; 1970, Volume 1, Characteristics of the Population, Pt.1, U.S. Summary*, Washington, D.C., June 1972.

US-558 U.S. Department of Commerce, Bureau of the Census, *Census of Population: 1970, Volume 1, Characteristics of the Population, Pt. 35, North Carolina*, Washington, D.C., October 1972.

US-559 U.S. Department of Commerce, Bureau of the Census, *Census of Population: 1960, Volume 1, Characteristics of the Population, Pt. 35, North Carolina*, Washington, D.C.

US-660 U.S. Department of Commerce, Bureau of the Census, *Census of the Population: 1970, Volume 1, Characteristics of the Population, Pt. A, Number of Inhabitants, Section I, U.S., Alabama-Mississippi*, Washington, D.C.

US-661 U.S. Department of Commerce, Bureau of the Census, *Thirteenth Census of the United States (1910), Volume 3*, *Population, Reports by States*, Washington, D.C.

US-662 U.S. Department of Commerce, Bureau of the Census, *Fourteenth Census of the United States (1920), Volume 3*, *Population, Composition and Characteristics of the Population by States*, Washington, D.C.

U.S.-664 U.S. Department of Commerce, Bureau of the Census, *Census of Housing: 1970, Block Statistics, Final Report, HC(3)-168, Greensboro, N.C., Urbanized Area*, Washington, D.C.

Chapter III

NO-111 North Carolina, State of, Department of Natural and Economic Resources, Division of Environmental Management, *Water Quality Management Plan, Cape Fear River Basin, Sub-Basin 02*, Raleigh, North Carolina, Environmental Management Commission, October, 1974,

RA-R-406 *Technical Reference Document Prepared for Greensboro, North Carolina Wastewater Treatment Facilities, EIS*, Austin, Texas, Unpublished.

ST-352 Stanley Consultants, Inc., *Wastewater Treatment Unit Processes Design and Costs Estimating Data*, Contract No. DACW21-74-C-0067, Savannah, Georgia, Savannah District Corps of Engineers, January, 1975.

VA-123 Van Note, Robert H., et al., *A Guide to the Selection of Cost-Effective Wastewater Treatment Systems*, EPA-430/9-75-002, EPA Contract No. 68-01-1973 and 68-01-1276, San Francisco, Bechtel, Inc., July 1975.

Chapter V

BO-054 Bolt, Beranek, and Newman, *Noise From Construction Equipment and Operations, Building Equipment, and Home Appliances*, PB 206 717, Cambridge, Massachusetts, 1971.

BU-264 Buchanan, Bill, Private communication, Manager, Central Rock Company, Greensboro, North Carolina, 28 June 1977.

CH-399 Chiara, Joseph de and Lee Koppelman, in Urban Planning and Design Criteria, 2nd Edition, New York, Van Nostrand Reinhold, 1975, pp. 331-33.

EN-071 Environmental Protection Agency, Compilation of Air Pollutant Emission Factors, 2nd Edition with Supplements, AP-42, Research Triangle Park, North Carolina, Feb. 1972, April 1973, July 1973, September 1973, July 1974, January 1975, December 1975, February 1976.

EN-108 Environmental Protection Agency, Office of Noise Abatement and Control, Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, EPA 550/9-74-004, Washington, D.C., 1974

EN-483 Environmental Science and Engineering, Inc., Evaluation of Potential Odor and Noise Production from the Proposed Arlington East Sewage Treatment Plant, 2 volumes, EPA Contract Order No. 68-01-2384, Task 1, Gainesville, Florida, September 1975.

EN-610 Environmental Protection Agency, Office of Water Program Operations, Design Criteria for Mechanical, Electric, and Fluid System and Component Reliability, EPA-430-99-77-001, Washington, D.C., undated

GR-283 Greensboro, City of, North Carolina, Application for a "Permit" to Construct and Operate Air Pollution Abatement Facilities and/or Emission Sources, Greensboro, North Carolina, undated.

GR-334 Greensboro, City of, North Carolina, Annual Budget for the Fiscal Year July 1, 1977- June 30, 1978, undated.

ME-050 Memphis State University, Effects of Noise on Wildlife and Other Animals, PB 206 720, 1971.

NO-111 North Carolina, State of, Department of Natural and Economic Resources, Division of Environmental Management, Water Quality Management Plan, Cape Fear River Basin, Sub-Basin 02, Raleigh, North Carolina, Environmental Management Commission, October 1974.

NO-139 North Carolina, State of, Department of Natural and Economic Resources, Sedimentation Control Commission, Rules and Regulations for Erosion and Sediment Control, April 1974.

PU-050 Putnam, Arthur L., Effect of Urban Development of Floods in the Piedmont Province of North Carolina, Raleigh, North Carolina, U.S.G.S., 1972

RE-118 Real Estate Research Corporation, The Costs of Sprawl, Government Printing Office, Washington, D.C., 1974.

US-562 U.S. Department of Agriculture, Soil Conservation Service, Guilford County Progressive Soil Survey, Interim Report, Interpretations for all Soils Identified and Mapped in Guilford County, March 1973.

Chapter VI

EN-101 Environmental Protection Agency, Processes, Procedures, and Methods To Control Pollution Resulting From All Construction Activity, EPA 430/9-73-007, Washington, D.C., 1973.

NO-139 North Carolina, State of, Department of Natural and Economic Resources, Sedimentation Control Commission, Rules and Regulations for Erosion and Sediment Control, April 1974.